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CONTENTS

Ancient Origins Magazine | Issue 17 | January 2020

FEATURES

08 The Origin of Snakes and Ladders – Transcending Lower Consciousness

18 Ancient Technology - Advanced Metallurgy and the Solar Laser of Archimedes

30 The Untold History of the Wheel

34 Blowing in the Winds - The Ancient Nashtifan Windmills of Persia

38 The Man Who Stopped a Desert with Ancestral Farming Techniques

48 Made in China – 8 Chinese Inventions That Changed the World

54 Ancient Tech Gone Wrong! The Birdman of Stirling Castle

60 Peruvian Archaeology Takes Flight With Drones

72 One Million Spiders Make the World’s Rarest Textile

18

72

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REGULARS

04 Editor's Note

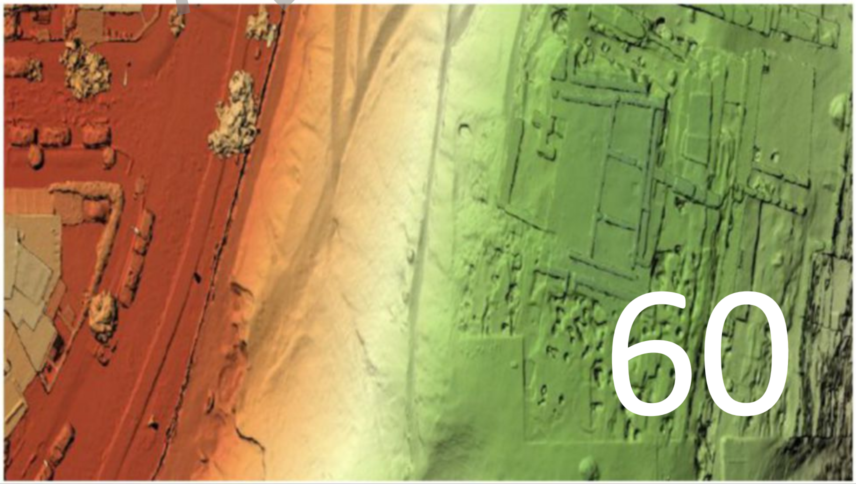
06 ArchaeoNews

14 Ritual Year – A New Year Brings Old Traditions

15 Artifact World – Measuring Heaven

78 Academy of Taste – Mesopotamian Mersu, Food Fit for a King!

06



60

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Ancient Origins Magazine| Issue 17 – January 2020 | Digital magazine $2.99
Publisher | Stella Novus Ltd, 6 Abbey Business Park, Baldoyle Industrial Estate,
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SPOTLIGHT: ANCIENT TECHNOLOGY

JOANNA GILLAN

Chief Editor, Ancient Origins Magazine

As the world looks on with shock and horror while Australia is ravaged by fires, we are reminded that at times our modern technology is simply not enough. From infrared sensors to satellites, drones, waterbombing planes, navy vessels, and thousands of firefighting tools at our disposal, nothing but Mother Nature, it seems, has the power to bring the fires to a close. So how did ancient people survive such disasters without technology to aid them? The truth is they did have technology, albeit in a different form. For tens of thousands of years, the indigenous people of Australia applied advanced land management techniques to create fire-resilient landscapes.

Today, sophisticated knowledge of the ancients is fading into obscurity as modern tech takes over, but in some parts of the world, it is being revived and used to solve present-day problems. Aztec floating gardens are being utilized in Mexico to achieve sustainable farming; in Iran, ancient Nashtifan windmills harness strong winds to grind grains, and in West Africa, one man even stopped a desert using centuries-old agricultural techniques.

Modern tech is now emerging as a powerful tool in the discovery, investigation, and preservation of ancient sites. Nowhere has this become more apparent than in Peru, where drones have been used to map more than 600 archaeological sites across the country. We talk to the COO of a drone technology company that is playing a key role in that process.

In this issue, we consider the advanced age-old wisdom that was used to solve everyday problems, while highlighting some awesome ancient inventions that changed our world forever, like paper, printing, wheels, rockets, and even forks, as well as surprising ancient tech that is just down-right cool, like solar-powered laser beams, spider-woven cloaks, and chess-playing mechanical robots!

Just as we still grapple with machinery and computers today, our forebears, too, had to wrestle with uncooperative technology. For one particular medieval inventor, more than just his ego was hurt when his alchemically-enhanced flying machine failed to perform for the king! If only parachutes had been invented!

The twists and turns of such advances and setbacks are played out in the surprisingly ancient game of Snakes and Ladders. It may have been only a childhood game for you, but it is full of hidden messages.

In viewing the long history of humanity, we come to realize that we have actually never been without technology. The ancients weren't technophobes or Luddites; quite the contrary. They enthusiastically harnessed tech to make their lives better (or at least more interesting!) ■

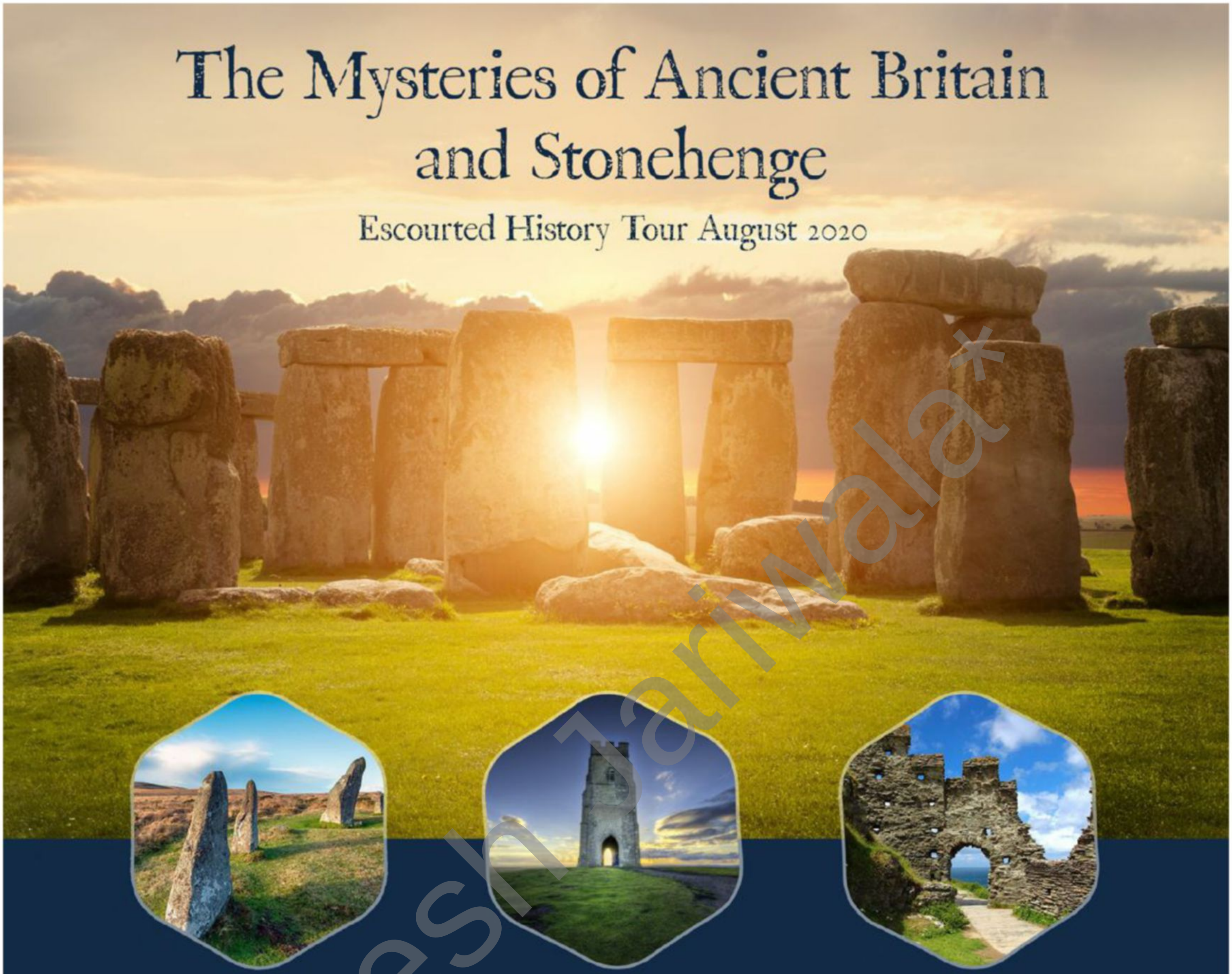
EXPERTS IN THIS ISSUE...

ÁLVARO RUIZ MOLANO

Álvaro Ruiz Molano is an electronics engineer and the Chief Operating Officer of CoatzaDrone, a Mexico-based company that applies drone technology to industries, including the mapping, recording and investigating of archaeological sites across Latin America.

DR. ROBERT VOLTERRI

Dr. Robert Volterri is an Italian archaeologist with specialties in Archaeometry, and collaborates with the University of Rome II for studies using Scanning Electron Microscopy. He is the author of more than 40 books on ancient and archaeological mysteries.



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Archaeonews

By Joanna Gillan

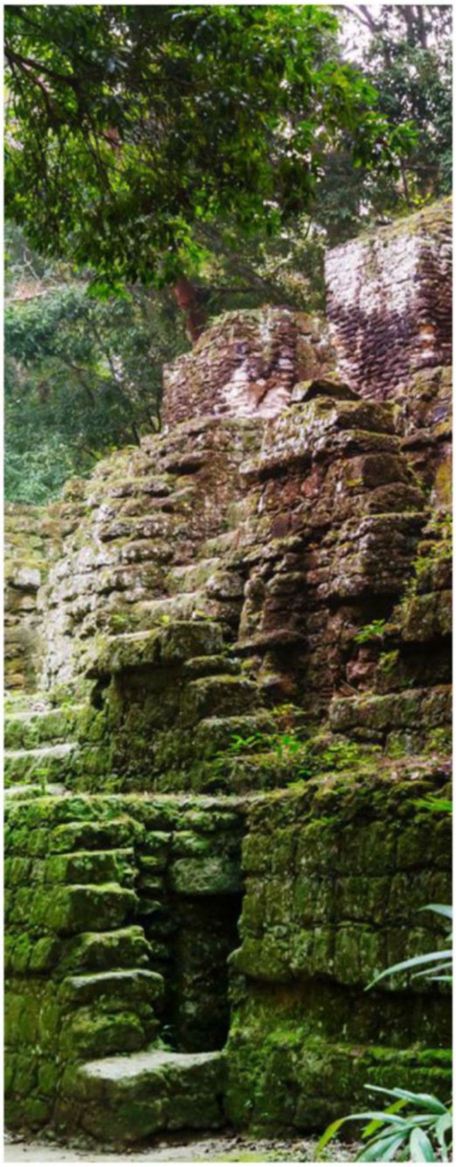
More Terracotta Warriors Found in Emperor’s Tomb

Chinese archaeologists found over 220 terracotta warrior statues in the Mausoleum of the First Emperor of China, Qin Shi Huang, adding to his enormous army of soldiers for the afterlife. The find is unique as the new warriors came with five different official titles, including senior military ranks, and a new military rank dubbed “lower than the lowest”.

The Terracotta Army is a collection of earthenware sculptures depicting the army of the First Emperor, mirroring the ranks, uniforms, and weapons of real soldiers of the Qin dynasty (221-206 BC). They were interred with Qin Shi Huang around 210 BC and were designed to defend him in the afterlife.

The army of clay figures was uncovered in Xi’an, north-west China in the 1970s, completely by chance and they have fascinated the world ever since. The latest discovery came after a decade of painstaking excavations at the site.

Among the warrior statues, archaeologists also unearthed crossbows, golden sabers, military tripods, and everyday items such as spoons, plates, and kettles. The newly discovered warrior ranks are providing new evidence on how the First Emperor’s army was organized and structured.



Maya Palace Emerges from Yucatan Jungle

An impressive Maya palace was found in dense vegetation in the Archaeological Zone of Kulubá in Yucatán and is now being excavated together with an altar, two residential spaces, and a round construction that was likely an oven.

Kulubá has Maya and Toltec influence and its architecture is similar to the more well-known sites of Chichen Itza and Ek Balam. The site was first discovered in 1939 by American archaeologist Wyllys Andrews IV and has gradually been recovering its former splendor as archaeologists work to peel back the layers of forest that have been enveloping it for centuries.

The palace ruins appear to have been occupied between 600 and 1050 AD. So far, researchers have unearthed a floor, stairs, and a corridor with pilasters (non-operational decorations made to look like columns) of the palace.

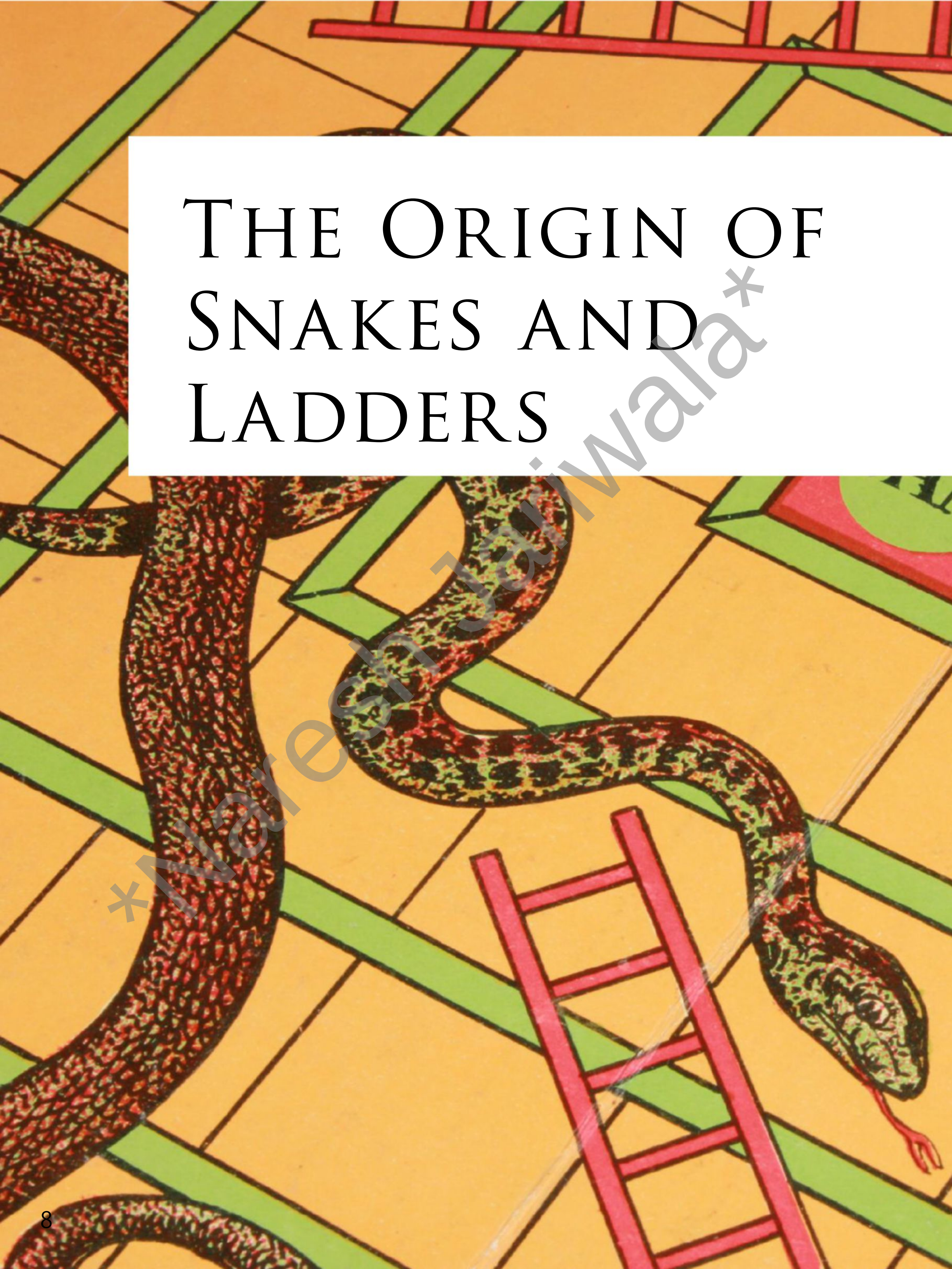
Another interesting discovery made at Kulubá is the presence of what is referred to as a 'secondary burial' (in which a person or people are re-buried in a location which was not their original burial site). These remains have been excavated and future anthropological work is planned with the goal of identifying the sex, age, pathologies, and habits of the Maya individuals who were re-buried at the palace.

Growing Ancient Lost Crops Brings Surprising Results

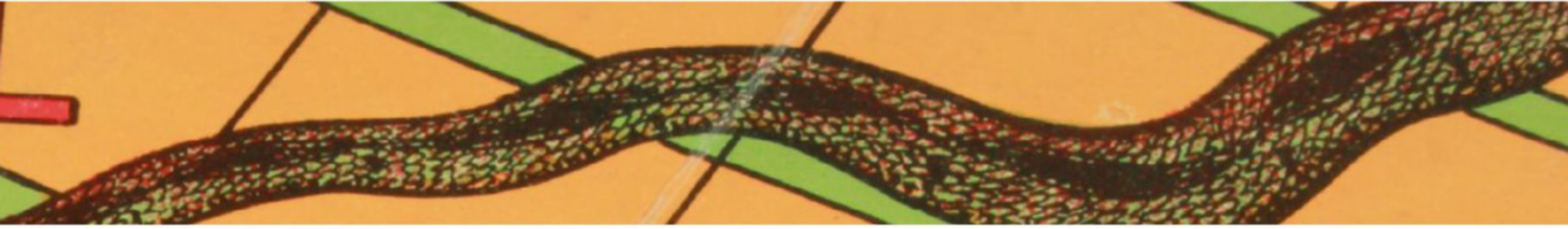
The scientific cultivation of the long-lost ancient crops, goosefoot, and erect knotweed, has yielded much higher than expected growth rates. Surprisingly, these crops might have fed as many (or more) people as traditional corn (maize) in prehistoric North America, which challenges previous assumptions.

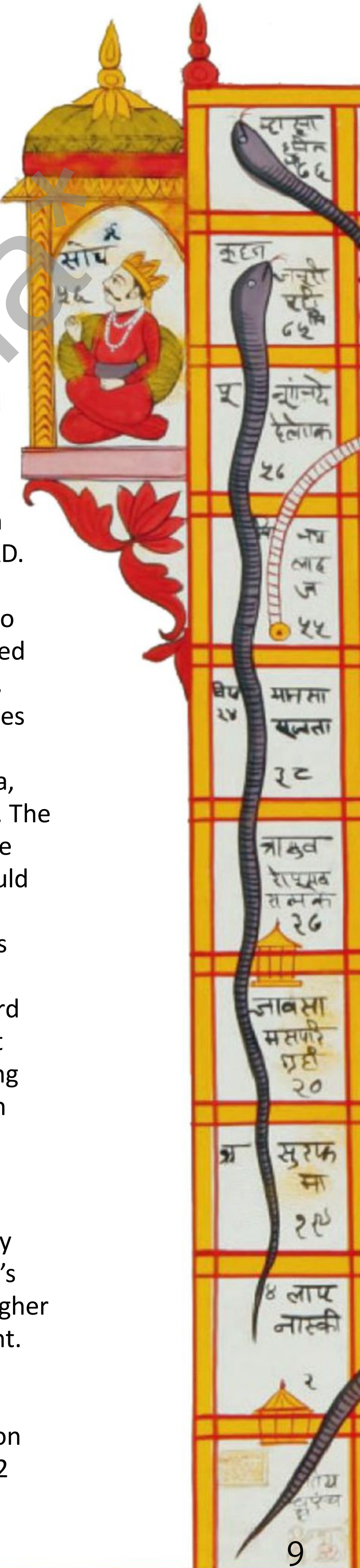
The first seed caches and dried leaves held as evidence of 'lost crops' were gathered in the 1930s by archaeologists in rock shelters in Kentucky and Arkansas. Over the past 25 years, researchers at Washington University established that the extinct crops had supported local indigenous societies for at least a thousand years, long before maize became their staple crop.

The lost crops were made up of diverse native grasses, seed plants, squashes and sunflowers, of which only the latter two are still cultivated today. The question as to why these "lost plants" were abandoned by indigenous cultures has been a point of debate among archaeologists. It has generally been assumed that maize was a lot more productive. However, the new research found that a polyculture of goosefoot and erect knotweed grew much more productively than when grown separately as a monoculture and, when grown together, these two plants yielded "higher than global averages" for closely related domesticated crops. ■



THE ORIGIN OF SNAKES AND LADDERS





Transcending lower consciousness to reach Moksha

By Wu Mingren

The game of Snakes and Ladders is today considered a classic and is loved by children from all over the world. While the game itself is known by most people, its origin is less well-known. As a matter of fact, the game of Snakes and Ladders is an ancient Indian invention, and was not played for mere entertainment, but had a philosophical dimension to it as well. The moral lesson of the game was to move from the lower levels of consciousness to higher consciousness and eventually reach spiritual enlightenment and *Moksha* - emancipation, enlightenment, liberation, and release from the reincarnation cycle of death and rebirth. In its epistemological and psychological senses, Moksha means freedom from ignorance: self-realization, self-actualization, and self-knowledge.

AGE-OLD GAME OF KNOWLEDGE

Originally, the game of Snakes and Ladders was known variously as *Gyan Chaupar* (meaning 'Game of Knowledge'), *Mokshapat*, and *Moksha Patamu*, and was originally a Hindu game. Nobody knows for sure who invented this game or when it was created. It has been speculated that this game was already being played in India as early as the second century AD. Others have credited the invention of the game to Dnyaneshwar (known also as Dnyandev), a Marathi saint who lived during the 13th century AD. However, game boards and ivory and bone pieces have been found in the Indus Valley Civilization at Mohenjo-Daro, Harappa, Lotanhal, Kalibangan, and Alamgirpur. The Indus Valley Civilization dates from the Bronze Age, meaning these pieces could have been in use any time from 3300 BC to 1300 BC, which of course makes the game much older than previously anticipated. In any case, this dice board game belonging to children of ancient India has retained its popularity among modern-day children, albeit in a much simpler form.

THE BOARD

It may be said that while the gameplay of Gyan Chaupar is the same as today's Snakes and Ladders, the board and higher objective of the game is quite different. Like the modern Snakes and Ladders board, the number of squares in that of Gyan Chaupar may vary. One version of this board, for instance, contains 72 squares, while another has 100.

A major difference between the traditional and modern versions is the fact that in the former, a virtue or a vice and the effects of these virtues and vices, or something neutral is attached to each box.

For instance, in an Indian Gyan Chaupar board of 72 boxes, squares number 24, 44, and 55 have the vices of bad company, false knowledge, and ego respectively. As the game places great emphasis on karma, the Hindu principle of cause and effect, each vice (the snakes' heads) has a corresponding effect. Thus, for the vices mentioned above, the corresponding effects are conceit or vanity, plane of sensuality, and illusion.

On the other hand, the virtues of purification, true faith, and conscience are contained in squares number 10, 28, and 46, and these lead to heavenly plane, plane of truth, and happiness respectively. In this version of the board, the goal is to reach box number 68, which is the plane of Shiva.

The board game is in the human shape—the universal being. The upper part of the board is the heavenly abode or the *Moksha dwar,* akin to the head of the cosmic being. A protruding square on the extreme bottom left and one square on each side of the board is indicative of its legs and arms. Even the way the snakes and ladders have been placed on the board does not change, whereas they vary widely in Hindu, Muslim, and Buddhist Gyan Chaupers.

RELIGIOUS TEACHING TOOL

This game was so popular that it was also adopted and adapted by other religions that existed in the Indian subcontinent. It is known that Jain, Buddhist, and Muslim adaptations of the game exist, as the concepts of cause and effect, and reward and punishment, are common to them. For devout followers of these religions, the game may be played as a form of meditation, as a communal exercise, and even as part of one's religious studies without the use of more conventional books or sermons. The Muslim version was used in the Mughal period from the late 17th or early 18th century. It is a 100 square Gyan Chauper which represents the number of names of god or 101, if the throne of Allah is counted. It is written in Arabic or Persian.

Many of the surviving game boards are works of art in their own right, as they contain elaborate illustrations of human figures, architecture, flora and fauna, etc. These boards were commonly made of painted cloth, and most of the extant ones date from after the middle of the 18th century AD.

THE MODERN GAME

The game of Gyan Chaupar became Snakes and Ladders towards the end of the 19th century, when it was introduced to Great Britain by India's colonial rulers. While the original gameplay was maintained, its underlying philosophical message was greatly diminished. The religious virtues and vices were replaced by two-part cartoon dramas connected either by a snake or a ladder. Additionally, the number of snakes and ladders were equalized, whereas in the original games, there were usually more snakes than ladders, which symbolizes the belief that it is far easier to fall prey to vice than to uphold virtue. From Great Britain, the game traveled to the United States, where it was introduced in 1943 by Milton Bradley as Chutes and Ladders. ■

10

28

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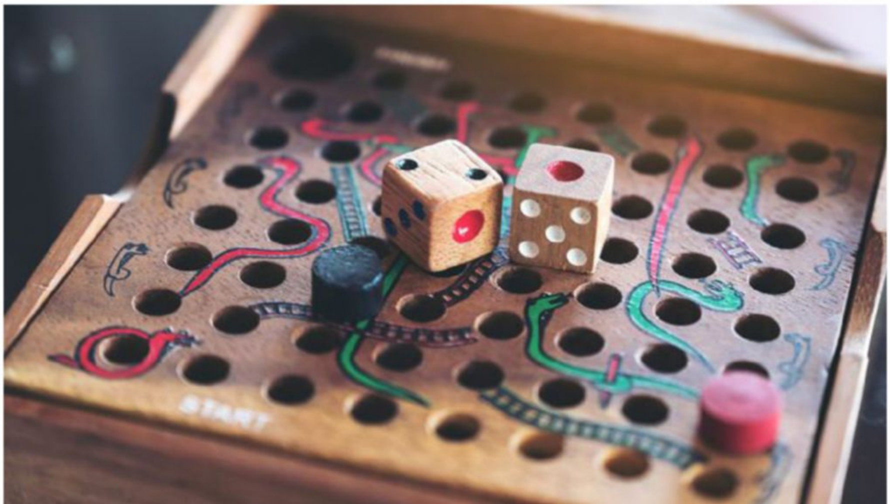
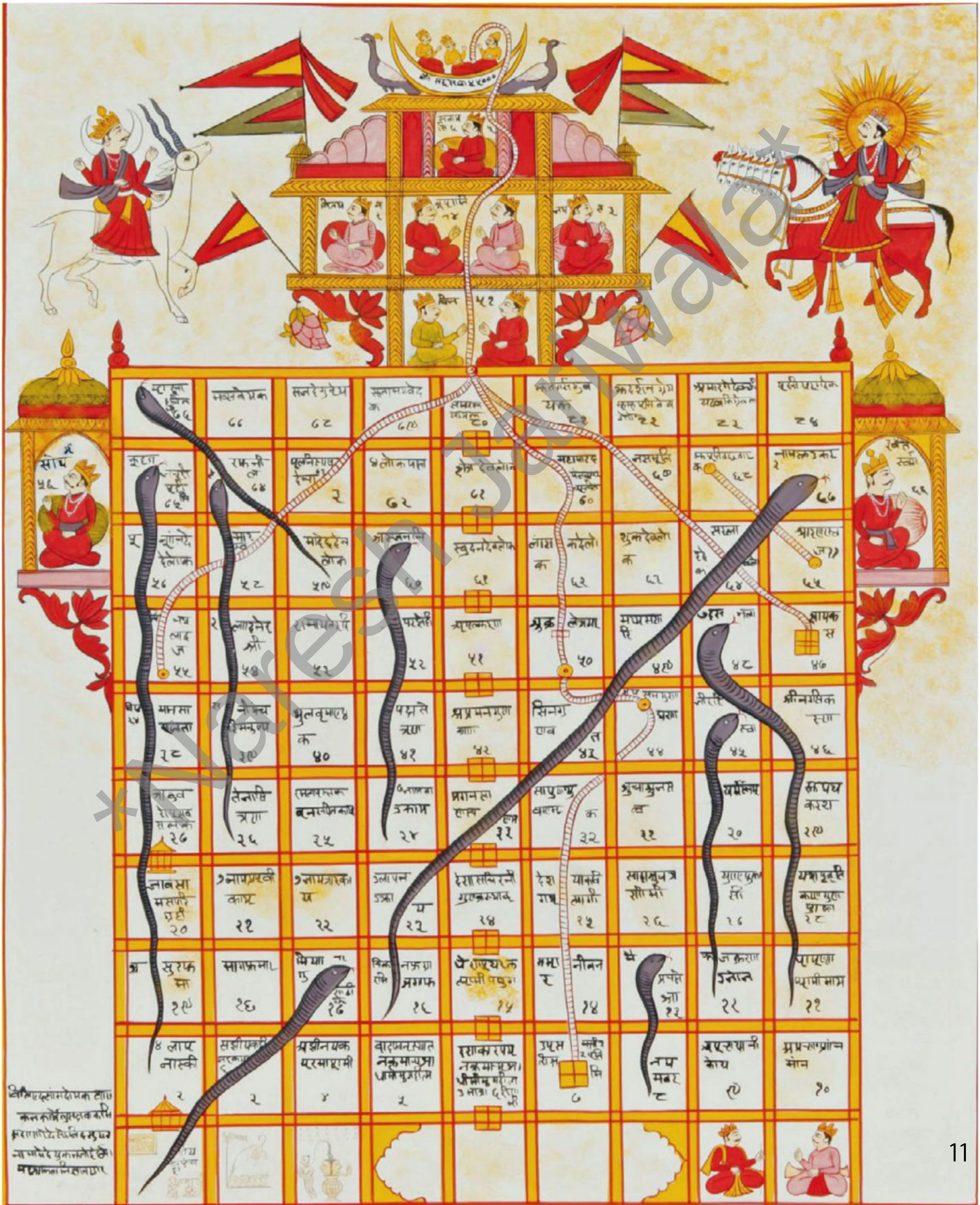
Opposite: Jain version of Snakes & Ladders called jnana bazi or Gyan bazi. India, 19th century, Gouache on cloth

Below: A more modern, wooden game board of Snakes & Ladders

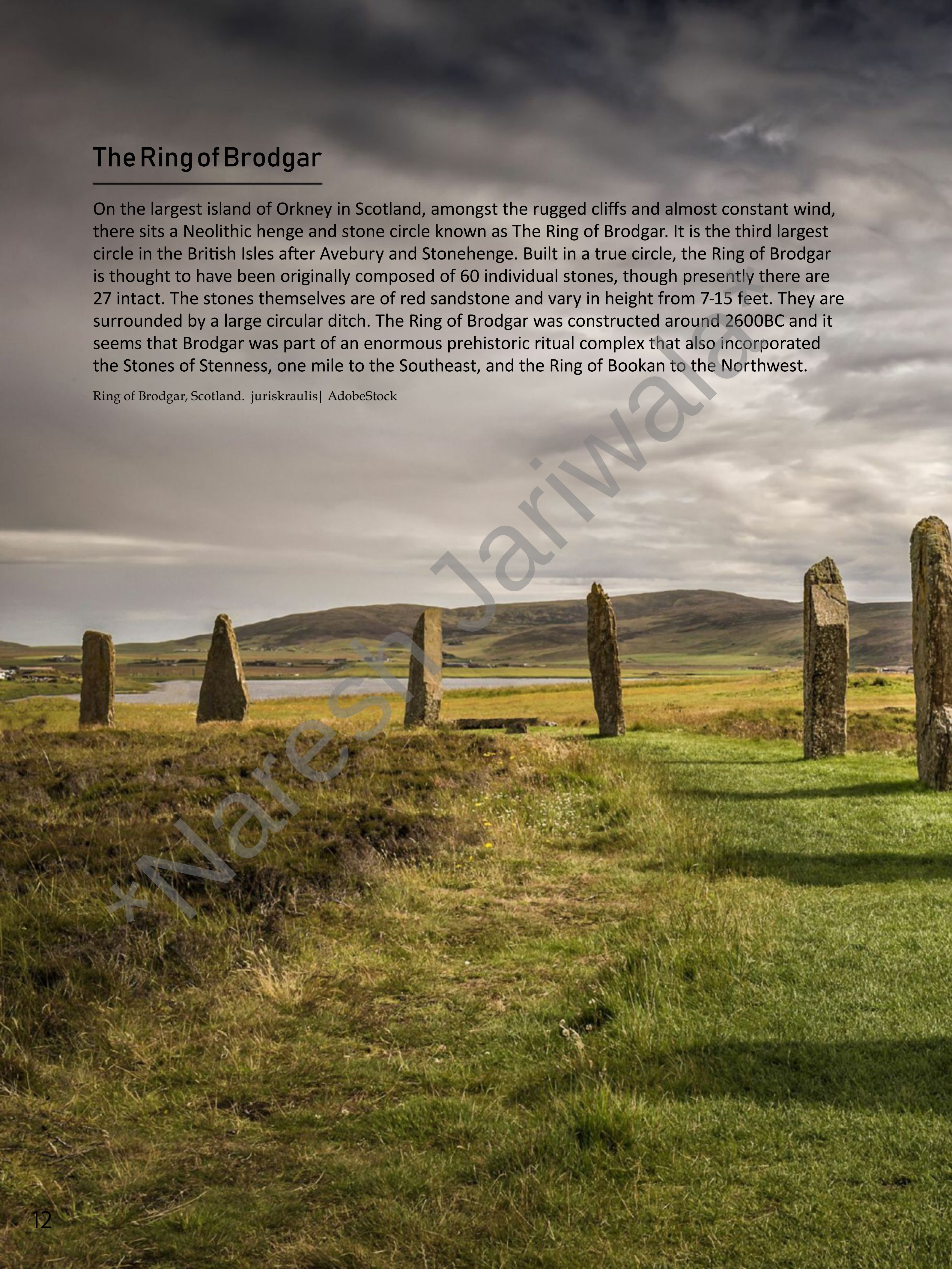


The game places great emphasis on karma, the principle of cause and effect, so each vice (a snake's head) has a corresponding effect



The Ring of Brodgar

On the largest island of Orkney in Scotland, amongst the rugged cliffs and almost constant wind, there sits a Neolithic henge and stone circle known as The Ring of Brodgar. It is the third largest circle in the British Isles after Avebury and Stonehenge. Built in a true circle, the Ring of Brodgar is thought to have been originally composed of 60 individual stones, though presently there are 27 intact. The stones themselves are of red sandstone and vary in height from 7-15 feet. They are surrounded by a large circular ditch. The Ring of Brodgar was constructed around 2600BC and it seems that Brodgar was part of an enormous prehistoric ritual complex that also incorporated the Stones of Stenness, one mile to the Southeast, and the Ring of Bookan to the Northwest.



Ring of Brodgar, Scotland. juriskraulis| AdobeStock

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DR. MICKI PISTORIUS

Ritual Year

A New Year Brings Old Traditions

Every good columnist needs a break, and so we stand in for our regular Charles Christian.

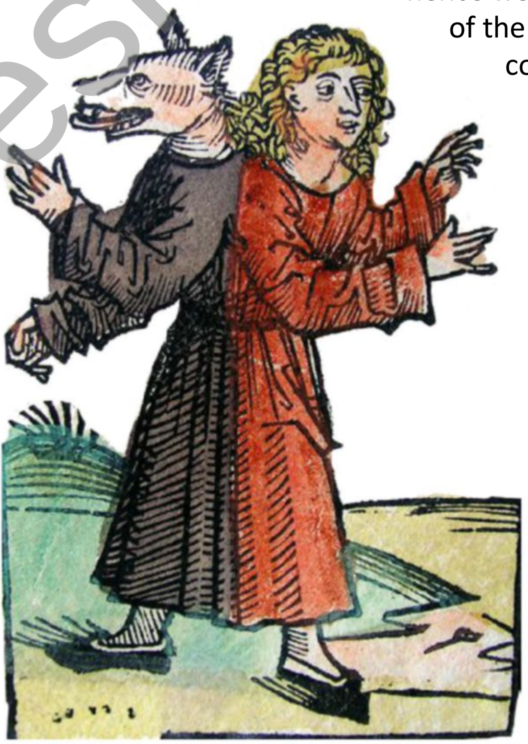
January 1, of course, saw billions of people all over the globe celebrating the first day of 2020, and by now lists of most New Year's resolutions have landed in the bin along with the discarded Christmas wrapping paper. But do not despair; you may revert to the Julian Calendar where the Old New Year is celebrated on January 14, and pick up your resolution with renewed vigor.

Old New Year is celebrated in Orthodox countries, harking back to a time when Russia and Eastern Europe still applied the Julian Calendar, proposed by Julius Caesar in 708 AUC (46 BC), in an attempt to reform the Roman Calendar. It was replaced by the Gregorian calendar, promulgated in 1582 by Pope Gregory XIII, which we use today. Celebrating old New Year does not differ much from celebrating new New Year, in the sense that much eating, drinking, and singing is involved.

Jumping ahead a month and the whole world – except for the cynics, realists, singles, and out-of-pocket young men – falls in love with Valentine's Day on February 14. The day commemorates the execution of St Valentine, who was tortured and put to death by the Romans on February 14, 269 AD, for marrying Roman soldiers and ministering to Christians. According to the legend, he signed his farewell letter "Your Valentine".

Sticking to Roman tradition, the day after Valentine's, we celebrate Lupercalia. In ancient Rome, the festival was held to ward off evil spirits and purify the city, to promote health and fertility. The Romans probably adopted the festival from the archaic Greek ritual conducted on Mount Lykaion (Wolf Mountain) which was related to preventing young men or *epheboi* from turning into werewolves. In Rome, the rites were confined to the Lupercal – the cave of Romulus, the founder of Rome, who was suckled by a she-wolf. A male goat was sacrificed by the Luperci priesthood, but the meal was prepared by the Vestal Virgins. Two of the Luperci would cut strips of skin from the goat, strip naked and run about whipping women with the thongs, in the belief that such a whipping would lead to pregnancy.

Lupercalia was also called *dies Februatus*, after the instruments of purification, *februa*. And hence we have the month Februarius, of the Julian Calendar. And so we come a full circle; if you are a day late for celebrating Old New Year's, you can still declare your undying love to a sweetheart, by offering her confectionary or gift her with a hand-written card, or you can get arrested for running around naked, swatting at women with a leather thong—so be sure to wear a Roman toga and celebrate Lupercalia with the publication of our Februarius issue on February 15! ■



In ancient Greece, young men were at risk of turning into werewolves!

***Regularly appearing in this space, Charles Christian** is a barrister and Reuters correspondent turned writer, award-winning tech journalist, radio presenter, podcaster, blogger, storyteller, and sometime werewolf-hunter who presents a weekly podcast: the Weird Tales Radio Show.*

MEASURING HEAVEN

FOLLOWING CELESTIAL OBJECTS IN THE ANCIENT WORLD

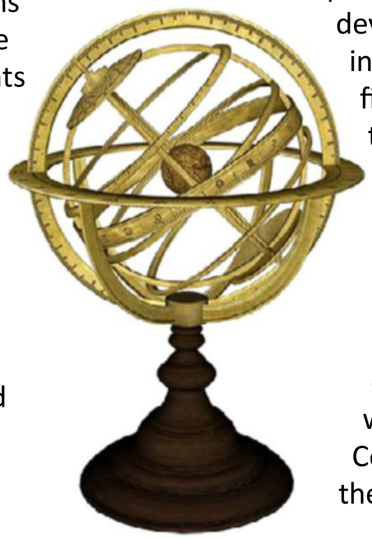
Astronomy is often considered to be one of the oldest branches of science. In many ancient societies, astronomical observations were used not only for the practical job of determining the rhythm of life, (e.g. the various seasons of the year, the celebration of festivals, etc.) but also for the philosophical exploration of the nature of the universe as well as that of human existence. One instrument developed to aid the important science of astronomy was the armillary sphere.

An armillary sphere is an astronomical device made up of a number of rings linked to a pole, which defines the axis of rotation. At the center of the sphere is the Earth. The rings represent the circles of the celestial sphere, such as the equator, the ecliptic, the Tropics, and the meridians. A band going around the sphere at an angle to the equator represents the constellations of the zodiac. The line that runs through that band is the ecliptic, which represents the annual pathway of the sun.

The instrument could be used to model movements of celestial objects and carry out calculations such as the times of sunrise and sunset, the length of a day, and the altitude of the sun or stars.

It is believed to have originated in the ancient Greek world, but by whom, however, is less certain. Some claim that the armillary sphere was invented sometime during the 6th century BC by the Greek philosopher Anaximander of Miletus. Others credit the 2nd century BC astronomer, Hipparchus.

The earliest reference to the armillary sphere, however, is said to have come from a treatise known today as the *Almagest* (known also as the *Syntaxis*), written by the 2nd century AD Greco-Egyptian geographer, Claudius Ptolemy. In this treatise, Ptolemy describes the construction and use of a zodiacal instrument used to determine the locations of celestial bodies in ecliptic coordinates. Ptolemy also gives examples of his use of this device for the observation of stars and planets.



Interestingly, the armillary sphere was also being developed independently in China, where it first appeared during the Han dynasty, 206 BC – 220 AD.

The earliest armillary spheres were geocentric, with the Earth placed at the center. Later models were based on the Copernican System with the Sun in the middle. ■

SECRETS of ANCIENT TECHNOLOGY

160
170
190
200
210
220
230
10
350
340
330
320

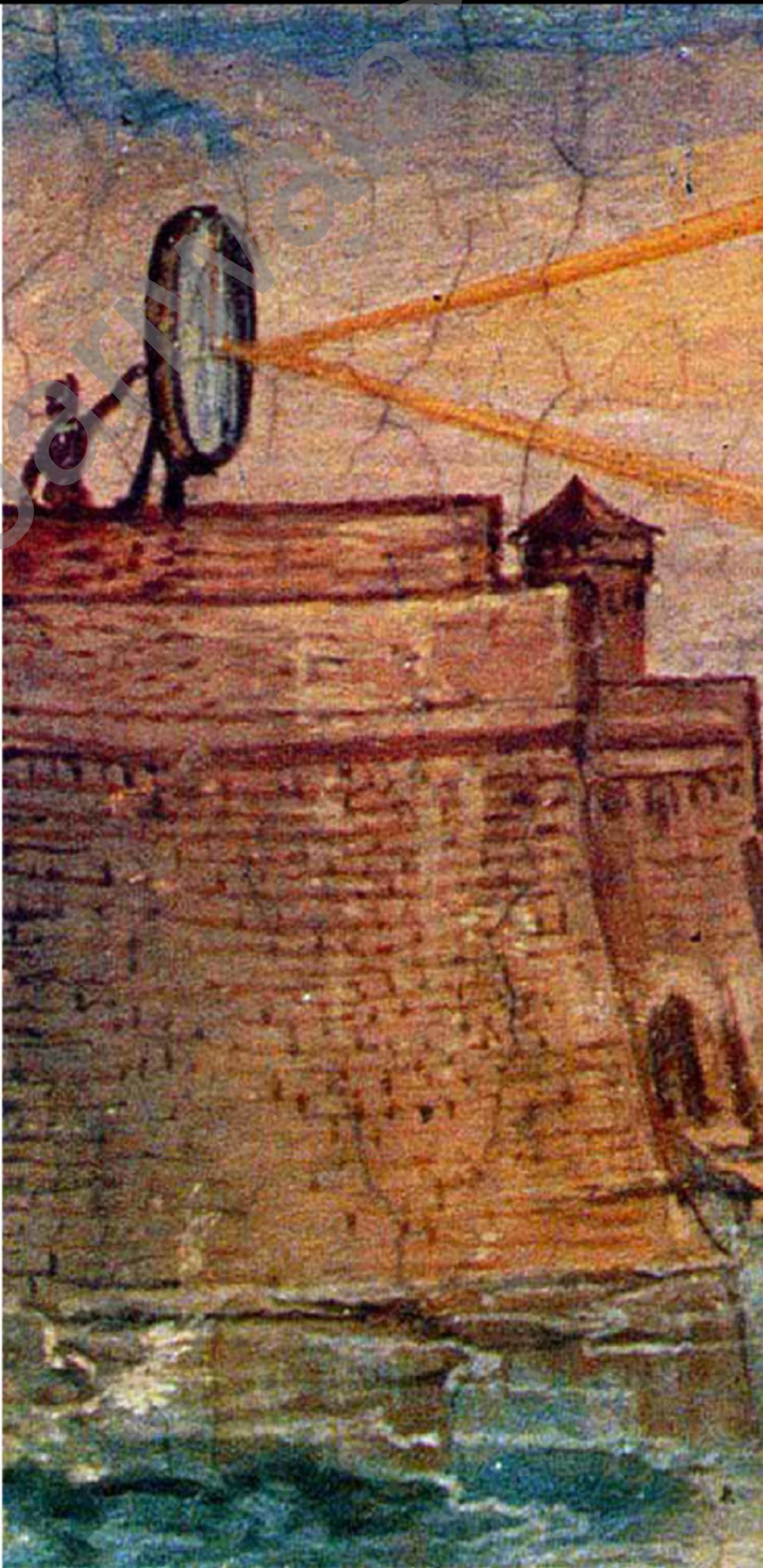
ANCIENT TECHNOLOGY

INTERVIEW WITH DR. ROBERTO VOLTERRI

BY DR. MICKI PISTORIUS

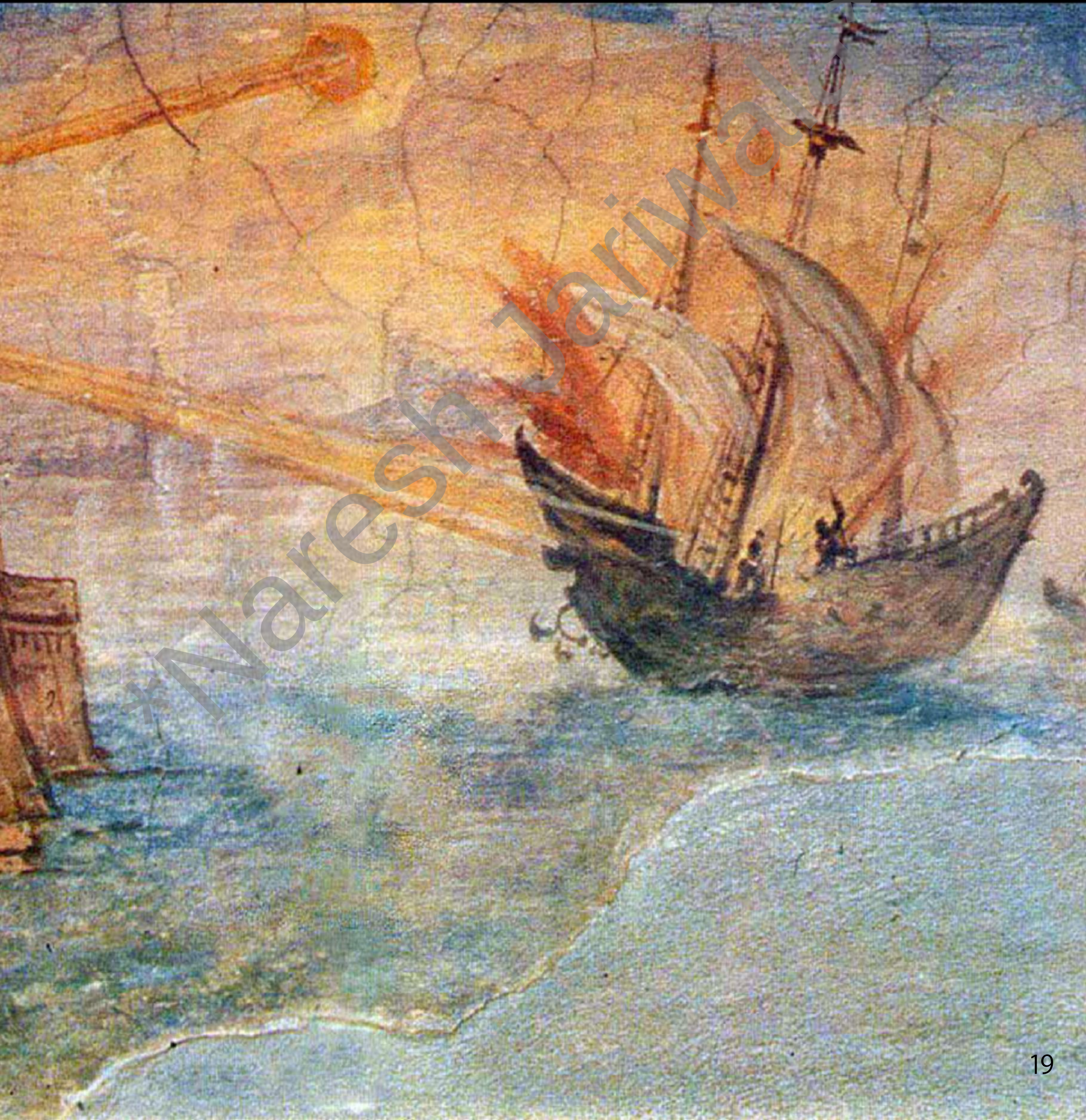
Naresh Jarin

Our ancient ancestors possessed knowledge about metallurgy that their descendants struggled to replicate. How did a famous goldsmith from Siena, Italy, Vanoccio di Biringuccio, manage to manufacture tiny gold sphere granules that were used to decorate beautiful jewelry? And how did the most famous inventor, Archimedes manage to design and manufacture an ancient laser to ward off Roman ships threatening to destroy his city of Syracuse? Fellow Italian Dr. Roberto Volterri, an academic at the University of Rome, developed a fascination for ancient archaeometallurgy and has spent more than 40 years researching this field. He studies findings of all metals through amenable survey techniques, such as Scanning Electron Microscopy (SEM), X-ray Diffractometry and Energy Dispersion Microanalysis (EDS). Dr. Volterri is a graduate in archaeology with an experimental thesis in archaeometry and author of 40 books.



Wall painting from 1600 showing Archimedes' mirror being used to burn a Roman military ship

ARCHAEOMETALLURGY, PYROTECHNICS, AND THE SOLAR LASER OF ARCHIMEDES



MP: Where in old literature do we read of the process of making gold granules?

RV: The goldsmith from Siena, Vanoccio di Biringuccio described in his 1540 work *'De la Pyrotechnia'*, the production of tiny gold granules in a bowl of water. In a small barrel with the shape of an inverted truncated cone, many minute gold spheres were collected, which would then be used to embellish gold jewels. The famous goldsmith Benvenuto Cellini explained in his '*Treatises*', published in 1568, a procedure fairly similar to that of Biringuccio: "... I take the gold or silver that I want to granulate and melt it and then pour it into a jar full of carbon pesto, and so I produce the granules."

How does this compare to the modern method?

Nowadays, a goldsmith craftsman would work in more or less the same way. To create a number of small gold spheres, the craftsman uses a blowpipe to melt small fragments of gold leaf or threads on a flat and well-polished carbon board, transforming the gold into perfect, tiny, gold spheres. When the little balls take shape, the carbon board is tilted slightly so that the balls, still in liquid form, slide into a small container containing cold water, where they solidify. The blowpipe consists of a small tube through which the goldsmith blows air over the flame of a candle, generating a heat source necessary to melt the gold particles into punctiform (shaped like dots).

How did they manage these pyrotechnics in ancient times?

It is uncertain if this blowpipe was in use many centuries ago. The use of a ceramic crucible in ancient times can be considered more plausible. A first layer of finely pulverized charcoal was placed in a ceramic crucible slightly larger than a coffee cup. Small gold particles (gold filings or very small fragments of gold reduced to a minimum thickness and then cut into small parts) were then placed on this layer. The goldsmith had to ensure that the gold particles did not come into contact with one another. The gold layer was then covered with another layer of charcoal, and the layers repeated.

A slight pressure exerted after each layer prevented the gold particles from moving or melting together. The crucible - provided with a special lid to work in a 'reducing' atmosphere, i.e. with a low oxygen content - was then placed over the flame in a glass beaker and heated to a temperature of about 2000 °F. Gradually, the fragments of gold melted, and according to a law of physics that requires them to find the balance with the smallest possible surface – they were shaped into tiny spheres.

Once the crucible had cooled down, it was carefully emptied, and the carbon residues were separated from the golden spheres. This was achieved by rinsing the gold granules in water, paying attention not to throw the smaller spheres out.

What happened to the little granules after they were formed?

The next phase consisted - in ancient times - of the selection of granules according to their size, using the grooves of a small seashell. Today we would use the so-called 'greendose', a small structure containing sieves with holes of decreasing diameter, placed one under the other.

The little balls were then picked up, with a small brush with wet bristles, and they were then adhered to the jewel by means of a proper 'glue'. The glue which Cellini calls *'acqua di dragante'*, was probably made from a jelly obtained from cooking fish or their bones. In some cases, the milky juice secreted by unripe figs was also used.

Above: Very small, almost all of them perfect, gold spheres made with the techniques described in this article. According to the engineer Mario Picherle, similar results could be obtained from the middle of the second millennium BC

Opposite: A shell; one of the methods for selecting gold balls according to their size was to use a Pecten valva Photos © Roberto Volterri

However, the real ‘glue’ was probably something else. In the fourth century BC, Theophrastus in his sixth book *‘De lapidibus’* wrote: “As for the stones... most of them are smaller and for this reason they are used to weld the gold, which can be welded by false emerald, as well as by chrysocolla…”. The word ‘chrysocolla’ gives us a clue: ‘chrysos’ means gold and ‘colla’ means glue. It refers to the well-known malachite or ‘Stone of Eilat’ obtained from the mines near the locality of the town of Eilat in southern Israel. There is speculation that these mines might be the famous mines of King Solomon and they have been mined since the fifth millennium BC. Chrysocolla, from a chemical point of view, is a basic copper carbonate and its chemical formula is $Cu_2(OH)_2CO_3$.

Perhaps even the best known ‘green copper’ described by Roman author Pliny the Elder in his *‘Naturalis Historia’* was something similar to chrysocolla. He claims that some copper sheets were immersed in vinegar and the layers of corrosion were scraped off as they formed.

MICROSCOPIC GOLD WORK IN THE BRONZE AGE

In 1808, William Cunnington, one of Britain’s earliest professional archaeologists, discovered what has become known as the crown jewels of the ‘King of Stonehenge’. They were found within a large Bronze Age burial mound just ½ mile from Stonehenge, known today as Bush Barrow. Within the 4,000-year-old barrow, Cunnington found ornate jewelry, a gold lozenge that fastened a cloak, and an intricately decorated dagger.

The handle of the dagger was adorned with up to 140,000 tiny gold studs just a third of a millimeter wide. The first stage involved manufacturing extremely fine gold wire, just a little thicker than a human hair. The end of the wire was then flattened to create a stud-head and was then cut with a very sharp flint or obsidian razor, just a millimeter below the head. This delicate procedure was then repeated tens of thousands of times. It is estimated that the entire process – wire manufacture, stud-making, hole-making, resin pasting and stud positioning – would have taken at least 2500 hours to complete.

The gold work involved such tiny components that optical experts believe they could only have been made by children or adults with extreme short-sightedness and would have caused lasting damage to their eyesight.

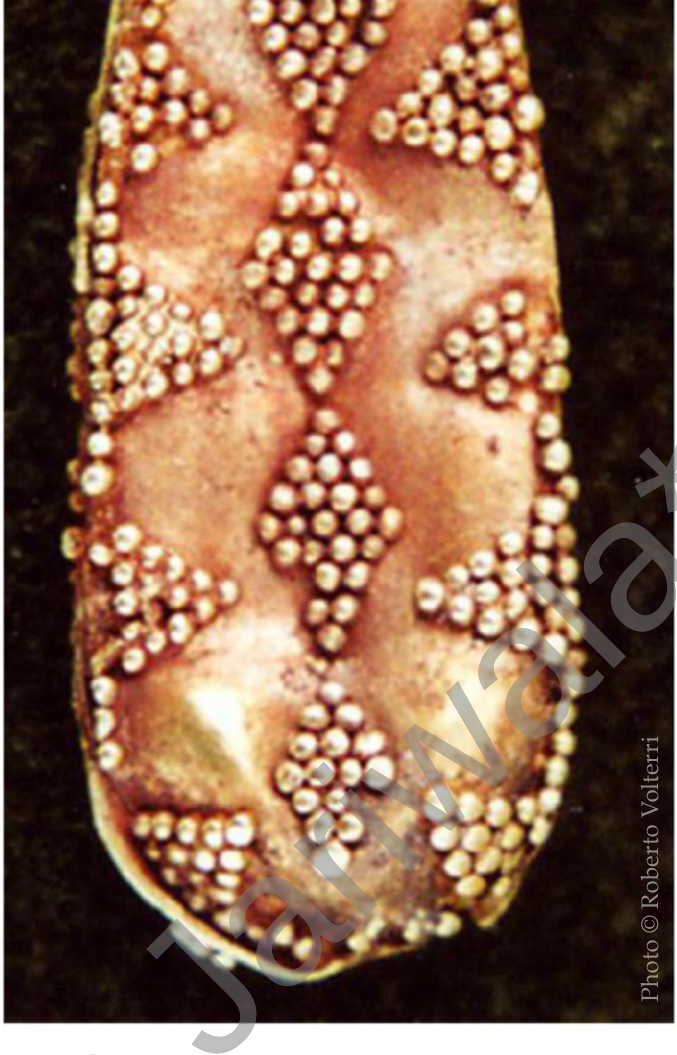


Photo © Roberto Volterri

Ancient jewel studied by Dr. Roberto Volterri to try to understand which techniques were used in the past to make the tiny gold spheres and the method by which they were glued to the jewel itself

Often, and it may sound unbelievable, to improve the result, a young man's urine was added! During the Middle Ages, dominated by intensive studies of 'alchemical' nature, the urine of a young man was replaced by calf urine, which some interpreted as a pseudonym for Mercury.

Other researchers interpret chrysocolla as a bivalent copper silicate, with a chemical formula: $CuSiO_3$-H_2O.

When it is heated, the charcoal reduces the chrysocolla to a copper metal that welds the golden balls to the surface of the artifact.

How are the gold granules welded by the modern heirs of those ancient goldsmiths?

Today, simple copper sulfate ($CuSO_4$) is dissolved with gelatin in water. The balls are picked up with a very thin brush of marten hair (N°00) and deposited on the gold base of the jewel. The excess amount of 'glue' is removed with absorbent paper and when the jewel is dry, it is heated with a flame of a Bunsen burner. Around 212 °F, a blackish substance begins to form between the balls while the copper sulfate is transformed into copper oxide (CuO).

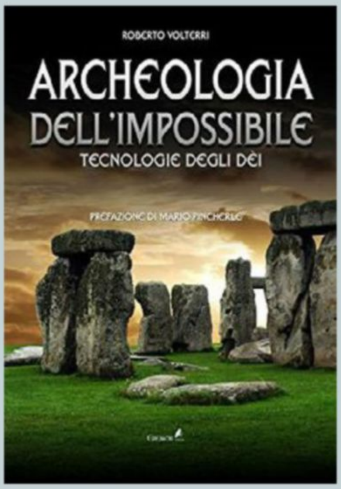
Around 1100 °F, the gelatin carbonizes, and at 1560 °F the copper oxide is transformed into copper metal giving up the oxygen. If the craftsman notices sudden metallic reflections between the little gold balls, he must immediately reduce the temperature of the Bunsen burner. Subsequently, everything is heated again and brought to 1600 °F, a temperature at which there is a close interaction between the atoms of copper and those of gold, which give rise to an alloy capable of permanently welding the little gold granules.

This Etruscan method inspired the Englishman H. Littledale to patent it in 1933. Subsequently, interesting studies on 'Etruscan granulation' were carried out by scholars of archaeometallurgy.

But was the method truly Etruscan or is there an older origin to the technique?

An ingenious paleotechnician of our time, the engineer Mario Pincherle (1919 – 2012), in his 2000 book *'L'Oro granulato'* argues that the so-called Etruscan granulation method was not Etruscan at all, but that it originated in the time of Sargon I and the Minoan civilization, more than 5,000 years ago. Pincherle, (now sadly deceased) assisted by Giuliana Cristianini Volpi, whom I had the pleasure to meet, experimented with a much older method.

Pincherle and Mrs. Volpi lived in Bientina, a beautiful Tuscan village, characterized by typical, low village houses, except for the seven-story building in which he lived. They extended the melting temperature to 1947 °F for the 24-carat gold and Pincherle placed a long tube (almost 65 feet) down the center of the stairwell. With the help of a powerful flow of compressed air, they literally threw the melted gold down the stairs in the tube, collecting the tiny perfect gold balls in a container full of cold water, located on the ground floor.

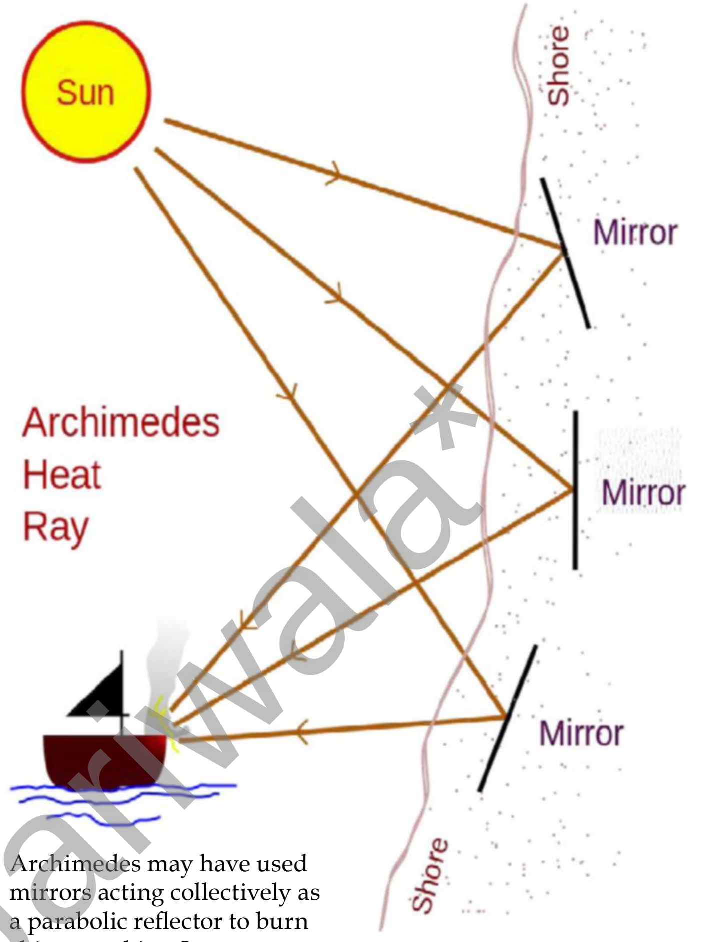


Archaeology of the Impossible

(Archeologia Dell'Impossibile)

By Dr. Roberto Volterri

It would be very hard to hope to find some of the artifacts described in *Archeologia Dell'Impossibile* in some museum because they do not exist, or have never existed. At least, 'officially'. This work, therefore, would like to fill this gap and should be understood as a real manual of "heretical archaeology"; indispensable to all those researchers of the unknown who want to face an experimental study on "possible ancient technologies", with the mental openness necessary to undertake a road full of obstacles— but above all with full respect for scientific orthodoxy.



Archimedes may have used mirrors acting collectively as a parabolic reflector to burn ships attacking Syracuse.

Finnrind/Pbroks13/CC BY SA 3.0

In so doing he emulated the method practiced on the Minoan islands of the Aegean Sea and in the lands of Sargon I of Akkad, 'lord of the four parts of the world', who dominated Mesopotamia, Syria and Asia Minor in the second half of the third millennium BC.

ANCIENT LASER WAR MACHINES

What prompted Archimedes to invent an ancient laser war machine, using solar reflection?

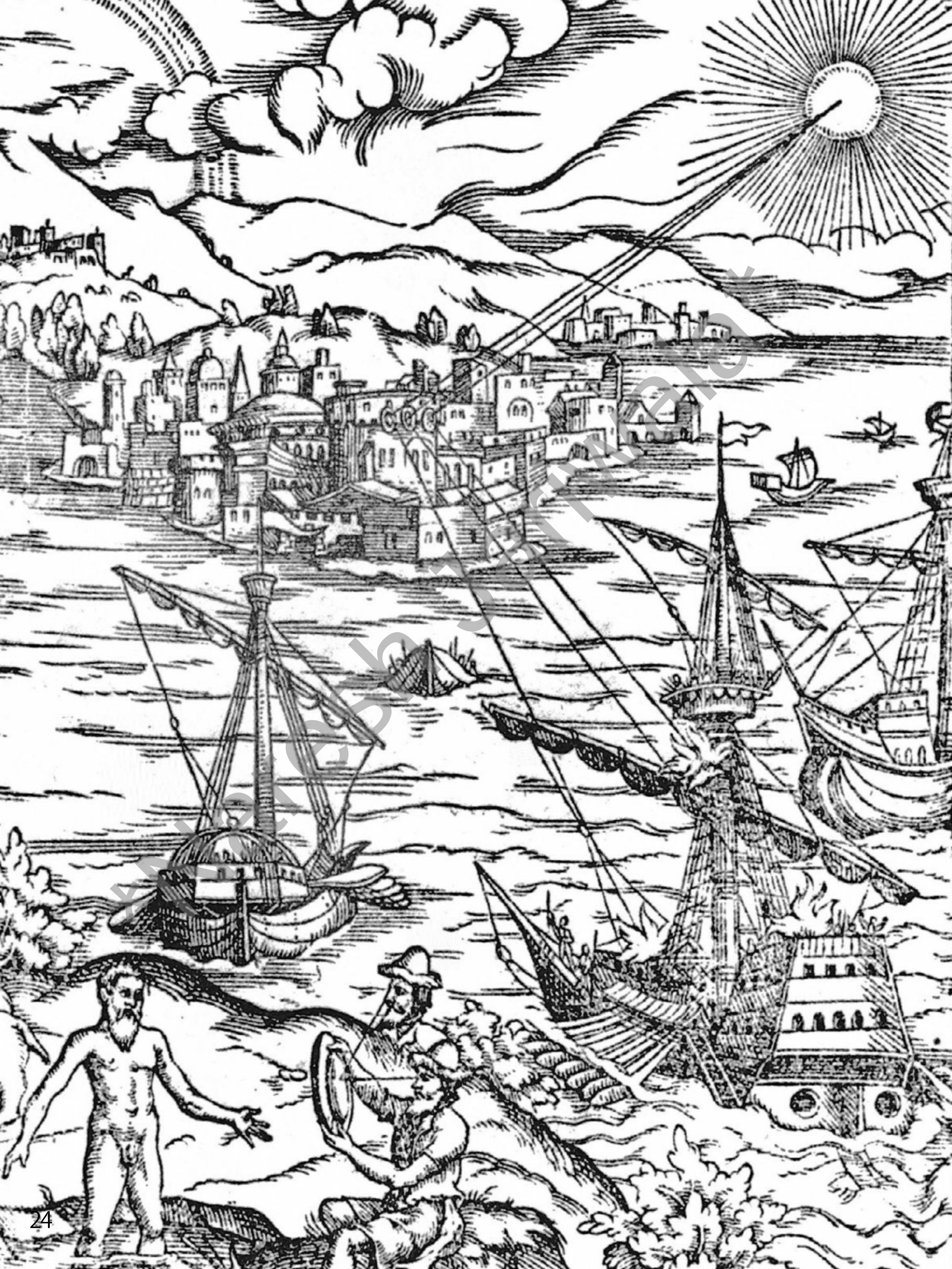
During the Second Punic War (218 – 201 BC) the Sicilian city of Syracuse decided to ally with Carthage against Rome. In 213 BC it was attacked by Roman ships and Consul Marcello had besieged this Sicilian city. The citizens of Syracuse turned to their local resident genius, Archimedes, who was by now in his 70's, for intervention.

Archimedes sensed the enormous power of sunlight when focused on a very limited area. He invented a system of mirrors that could dramatically increase the intensity of light and heat emanating from the sun. Archimedes designed, and the Syracuse craftsmen engineered, a rudimentary laser of antiquity - the so-called 'ustorii mirrors' (from the word *ustor* meaning he who burns the corpses) that were capable of burning flammable material, such as the wood of ships, when they ventured within the 'focal point' of the optical system.

According to Archimedes' calculations, the ustorii mirrors were to have the shape of a 'rotating paraboloid', that is, a surface generated by rotating a parabola around its axis. (The definition of a paraboloid is a symmetrical open plane curve formed by the intersection of a cone with a plane parallel to its side.) The paraboloid has a point where all the light rays converge, parallel to the axis, which are reflected on the surface of the paraboloid itself. In a modern explanation, it is the point where the car headlamp bulb is placed.

All this is possible because the sun is a considerable distance from the earth (91.5 million miles). The rays coming from the sun can be considered all parallel and, reflecting on the inner surface of the paraboloid, they all concentrate at one point, called the 'fire', with all their infinite luminous and thermal energy.

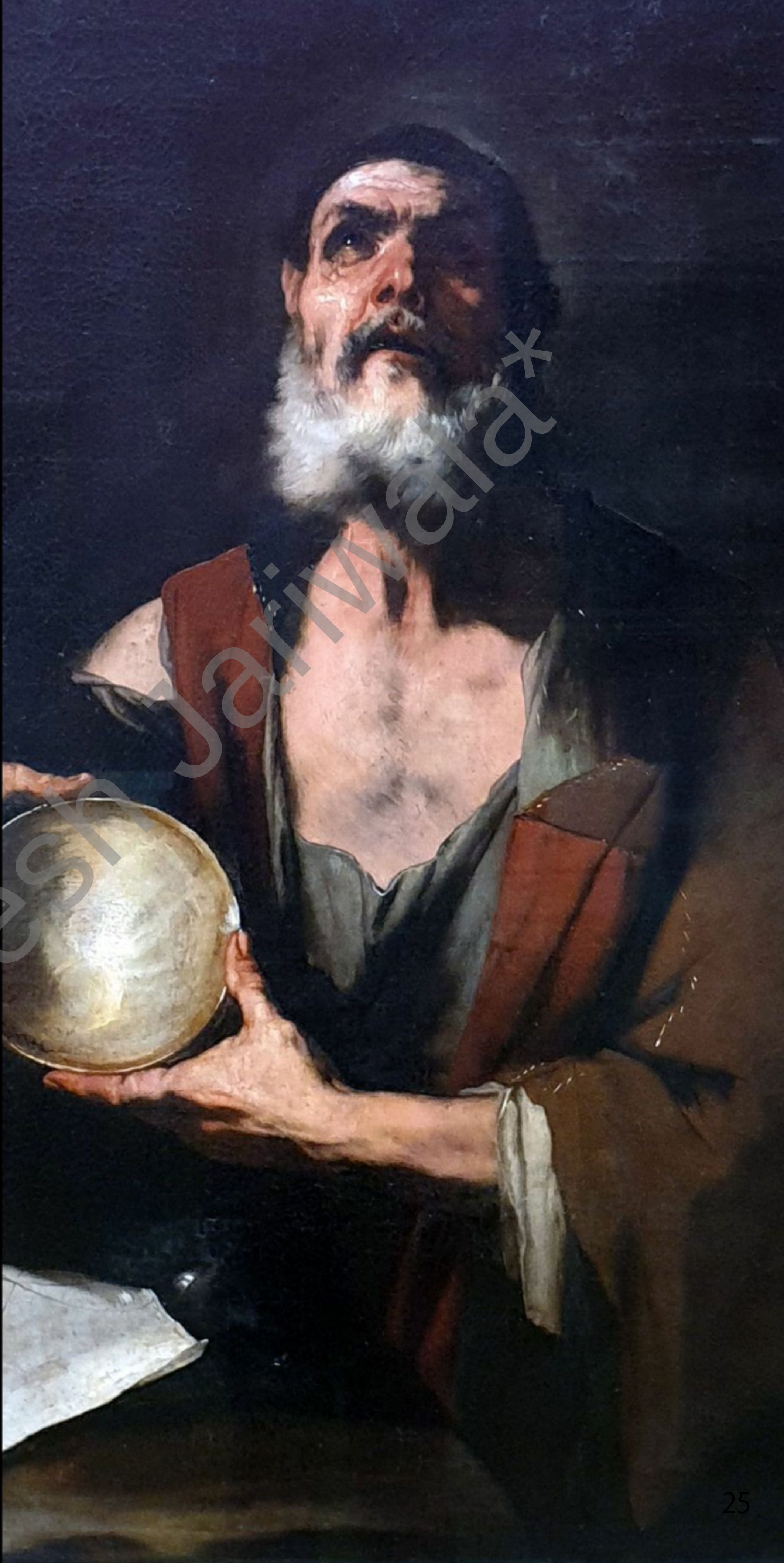
Continued page 26



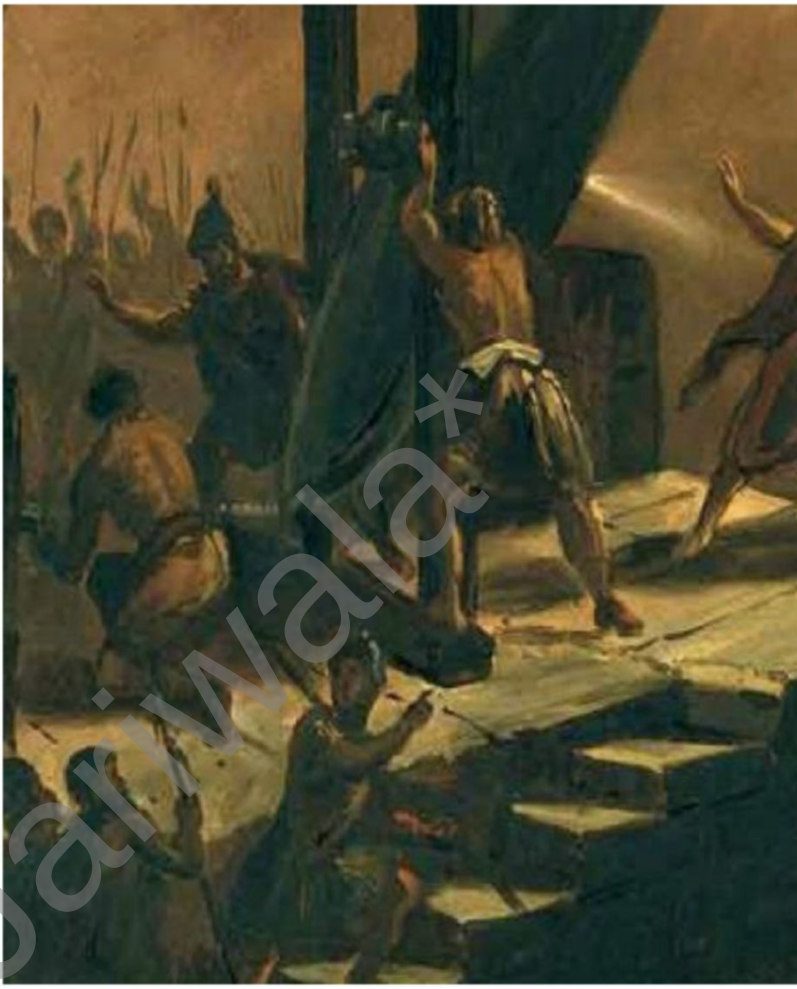
GENIUS

AHEAD OF HIS TIME

Archimedes was a Greek mathematician, scientist, mechanical engineer, and inventor who is considered one of the greatest mathematicians of the ancient world. The father of simple machines, he introduced the concept of the lever and the compound pulley, as well as inventions ranging from water clocks to the famous Archimedes screw. He also designed devices to be used in warfare such as the catapult, the iron hand, and the ustorii mirrors. Archimedes was one of the world's first mathematical physicists whose inventions were actually applied to the physical world.



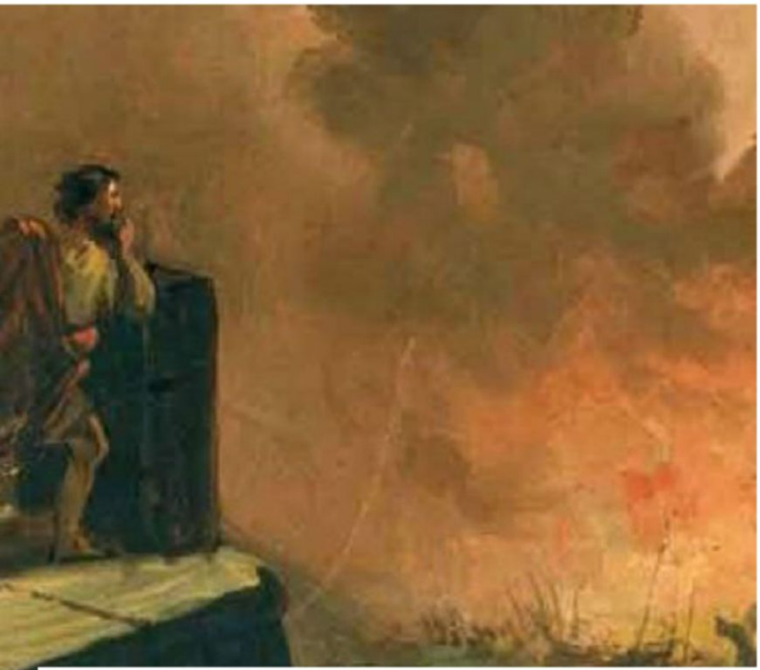
In the 16th century, some experimental physicists tried - based on Plutarch's more than meagre descriptions - to reconstruct this fearsome weapon of war, with little success. Only Bonaventura Cavalieri, a pupil of Galileo Galilei, came close enough to an acceptable result. He used two parabolic mirrors of different sizes. The larger one had to concentrate the solar radiation in its 'focal point', where the smaller parabolic mirror was placed, with its 'fire point' coinciding with the 'fire point' of the first mirror. Since the smaller mirror was orientated differently, the concentrated solar radiation from the larger mirror sent out parallel rays, but much more concentrated and therefore emitting a very large thermal energy. Difficulties in fine-tuning the optical system of mirrors with extreme precision and the overheating of the smaller mirror soon made this ancient laser useless and put an end to the experiments. In 1747, the great French naturalist Count Buffon tried a similar experiment in Paris in the royal gardens, but with very little success.



Was Archimedes' war laser ever reproduced?

Yes, by our very same professor Pincherle, who had become Dean of the Professional Institute for Industry in Osimo, in the province of Ancona. He realized it was unlikely that Archimedes - however ingenious - was able to make large curved mirrors, so it is conceivable that he used a series of flat mirrors arranged in such a way as to generate a large paraboloid. He recognized another difficulty would have been to concentrate the thermal energy coming from the sun on moving objects such as ships, because the paraboloid has only one 'focal point' and it would have been difficult to maneuver it in relation to the movements of ships.

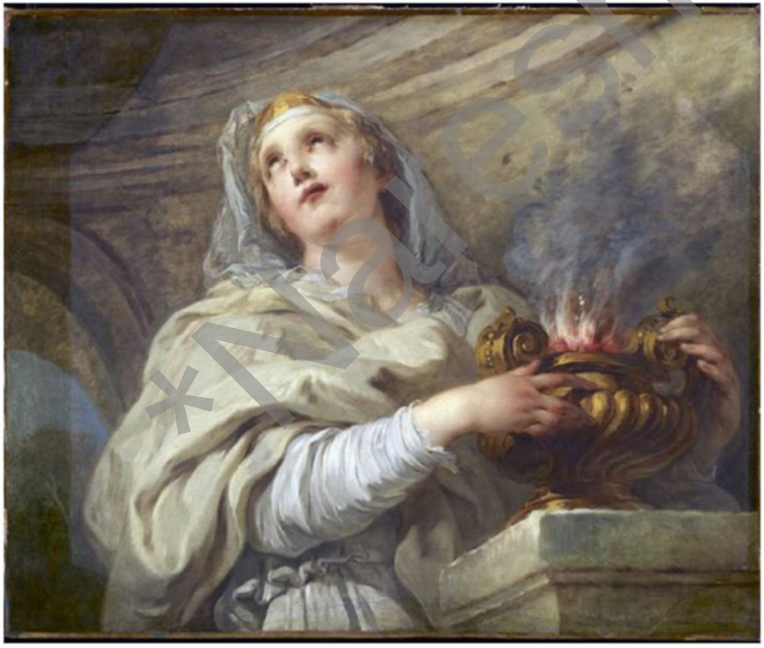
With the help of colleagues and willing and curious students, engineer Pincherle made his first experiments with flat, rectangular mirrors with sides that were only a few decimeters long. Then, encouraged by the promising results, he



Bottom left: The model of a Roman ship built by engineer Mario Pincherle to demonstrate how it is possible that Archimedes set fire to the sails of enemy ships by concentrating solar thermal radiation, clearly visible on the sail, 1972

Above: Archimedes setting Roman ships of Consul Marcellus on fire with a burning mirror | Cherubino Cornienti, 1855

Below: A Vestal Virgin tending the fire | François Lemoyne, 1726



set up the real "war machine", using many other mirrors fixed on a metal surface.

Finally came the long-awaited March 22, 1972, when a simulation of a wooden ship with dry sails, was erected on the school square. In full synergy, Pincherle and some students pointed the light and the heat from their reconstructed ancient war laser at the ship. The sun reflected from the mirrors to the sails. It took only a few minutes and the 'enemy' ship caught fire, greeted by understandable cries of satisfaction from the improvised little 'Syracuse army'.

Was the ancient laser technique of solar reflection used before Archimedes?

Plutarch, wrote in his work *'Parallel Lives*', how the second King of Rome, Numa Pompilius inspected the Vestal virgins, whose responsibility it was to keep the sacred fire burning. The fire represented their uncontaminated chastity, serving as a moral compass for the citizens of Rome and guaranteeing their wellbeing. Should the fire for some reason be extinguished, due to its sacredness, it may not be contaminated by lighting it with another fire, but rather with the pure and unpolluted flame of the sun. According to Plutarch, the Vestals used vases, of which the concave structure was formed by the side of an equicrural triangle (having equal legs or sides; isosceles), of which each point folded and collimated from the circumference to a single center. When these vases were placed facing the Sun, its sunlight splendor gathered from all sides to interweave in the center, and immediately ignited the dry tinder, to light the sacred fire. All this in the second half of the eighth century BC!

Dr. Volterri, have you replicated similar ancient technology?

I reconstructed panels made of thin sheets of reflective aluminum to replicate the "ustorii mirrors" as described in my book "*Archaeology of the Impossible!*" ■

GO TO THE NEXT PAGE TO
LEARN HOW TO MAKE YOUR
OWN USTORII MIRRORS

HOW TO CONSTRUCT THE USTORII MIRROR

DR. ROBERTO VOLTERRI

Since it will undoubtedly be difficult to get a large satellite dish to be modified into a parabolic mirror, Dr. Volterri recommends purchasing two plywood panels measuring 24 x 24 inches, 0.19 inch thick, and three small hinges.

1. Carefully glue strips of ‘aluminum foil’ for domestic use onto only one side of both the panels, with the ‘mirror’/ reflective side facing outwards. Avoid tears or creases when gluing the sheets to the plywood.

2. To achieve better results, cover it with self-adhesive plastic without delay.

3. Fix the hinges to the panels to make two hinged ‘doors’ that can be opened or folded close. The hinges will allow one to modify the ‘focal point’ of the improvised reflective system that will replace the larger parabola.

4. A different and more effective solution would be to make many different reflective panels - not hinged together - and have them operated by some willing participating experimenters, just as Pincherle enlisted the help of his pupils in the 1970s. The experimenters would have to concentrate the solar radiation simultaneously on the target to ‘ignite’ it.

5. The best solution, however, would be to obtain a number of disused satellite dishes. In this case one could glue the reflective aluminum foil on their inner surfaces, avoiding excessive folds. One will know exactly where the ‘focal point’ of the dish is, as it coincides with the point where the actual antenna was fixed.

© Roberto Volterri

Dr. Roberto Volterri shows one of the panels covered by a thin sheet of reflective aluminum to reproduce the “ustorii mirrors” described in his book “Archaeology of the Impossible!”

6. Using strips of well- seasoned wood and dry paper— for the ‘sail’ – construct a small simulation of a Roman ship. Or, just pile up some sheets of well-dried newspaper.

7. On a sunny day, shortly before or after the sun reaches its zenith, place the ‘target’ in the open air, on the ground, in a place where one can act freely without the risk of being accused of arson!

8. With a steady hand and acting also on the angle formed by the two flat reflecting panels, or orienting the ‘parabolas’ with the ‘mirror’ surface, make the solar radiation converge simultaneously on a single point through the various panels that one has entrusted to one’s willing collaborators, directing the reflected heat towards the intended target. The concentrated sunlight - with the relative thermal radiation amplified by the improvised optical system - after a while, will ignite the target. ■

SAFETY FIRST: As with any scientific experiment, safety precautions should be taken, including eye protection and having a source of water, hose, or bucket handy in case of success!

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ANCIENT ORIGINS DNA

The Untold History of The Wheel

By David Waters

The wheel can be considered mankind's most important invention, the utility of which is still applied in multiple spheres of our daily life. While most other inventions have been derived from nature itself, the wheel is 100% a product of human imagination. Even today, it would be difficult to imagine what it would be like without wheels, since movement as we know it would be undeniably impossible.

Humans have used animals as a mode of transport for a long time. However, wheels have a fascinating story behind their evolution. It took humans centuries to discern the many ways wheels could be utilized; they are now an integral part of our society and are expected to remain so for centuries to come.

Technically, the wheel should have been invented long before it actually was

A wheel, or a symmetrical unit revolving on an axis, forms the basic component of any given mechanized system today, whether it is a watch or a jet engine. The world moves on wheels today, but the inception of this technology can be traced back to 3500 BC in Mesopotamia.

Technically, the wheel should have been invented long before it actually was, as several other problem-solving inventions like sewing needles, boats, rope, and others preceded it. When the idea was finally conceived, it was not for the purpose of transport, but for pottery. About 300 years later, (in 3200 BC) it was first used in Mesopotamian chariots.

Mahesh Jaiswal

Interestingly, before they were used for transportation they may have been used for manufacturing or industrial purposes.

Many researchers are of the opinion that the wheelbarrow, which is a hand-drawn vehicle with one wheel in the front, was first invented in Greece between the 6th and 4th centuries BC. It then found its way to China 400 years later, from where it rolled into medieval Europe.

Even after it was learned that wheels could be used on vehicles, ancient people still relied on camels for transportation. In the Middle East, wheels were mainly used for domestic purposes like pottery making, irrigation, and milling.

Iron rims around wheels were first used in 1000 BC on Celtic chariots. After that, there was no major change in spoked wheels until 1802, when the very first wire tension spoke was patented by G.F. Bauer. It took several years more to evolve into the round wire tension spokes that are used for bicycles today.

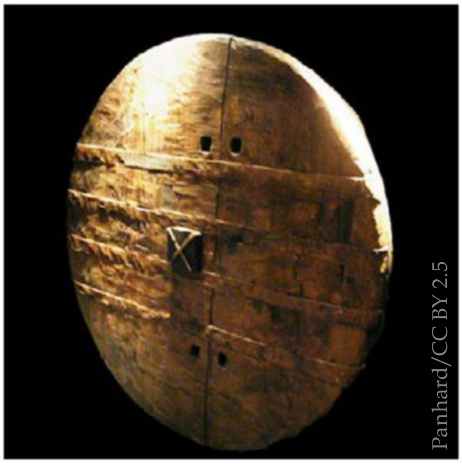
The invention of pneumatic tires followed, and a patent for it was registered by R.W. Thompson in 1845. It was further developed by John Dunlop, who replaced the hard rubber used in the bicycles back then with his pneumatic tires, and patented it.

The Benz Patent Motorwagen of 1885 by Karl Benz was a vehicle that used three wire wheels, like in bicycles, with hard rubber fitted around them. André and Edouard Michelin, the founders of the well-known tire company Edouard Michelin, were the first ones to think of using rubber on automobiles. Carbon was added to rubber to prolong the life of the tires in 1910 by B.F. Goodrich Company.

In 1926 and 1927 the first steel welded-spoke wheels were invented. The wheel continued to evolve even after that in the invention of disc wheels, which had a resemblance to the initial solid wheels. The demand for low-cost wheels led to the discovery, since making steel wheels cost much less.

The world today is heavily dependent on wheels, without which it would literally grind to a standstill. ■

Why the long wait?



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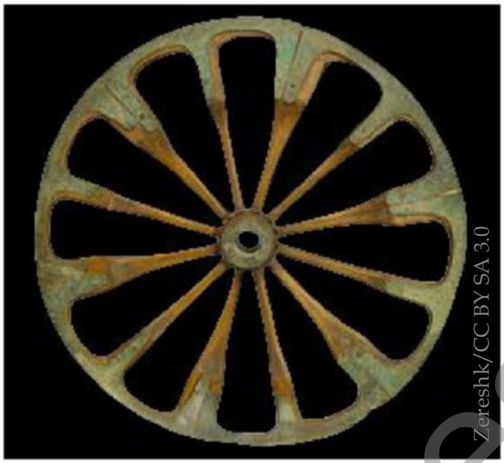
Above: Ljubljana Marshes Wheel, from c. 3150 BC, is the oldest known wooden wheel in the world

The wheel, as a means of transportation, was invented at a relatively late point of human history – 5,500 years ago. By this time, human beings were already writing, farming, building and producing metal alloys. So why the long wait?

To most of us, wheels seem pretty intuitive – round things roll, surely that's a lot easier than pushing, pulling, or carrying! But the real challenge in ancient times was working out how to make the wheel operate as part of a larger system of moving parts. The wheel was not just a cylinder rolling on its edge. It was a cylinder that was connected to a stable, stationary platform. This wheel-axle concept was a stroke of genius, but making it was a challenge. The ends of the axle, as well as the holes in the center of the wheels, had to be nearly perfectly smooth. Metal tools were needed to chisel these fine-fitting holes and axles. Failing to achieve this precision would result in too much friction between these components, and the wheel would not turn. Although the axle had to fit snugly in the holes of the wheels, they also had to have enough room to allow them to rotate freely. Given the complexity of the wheel-axle combination, it may be unsurprising that the wheel was not initially invented for transportation purposes.



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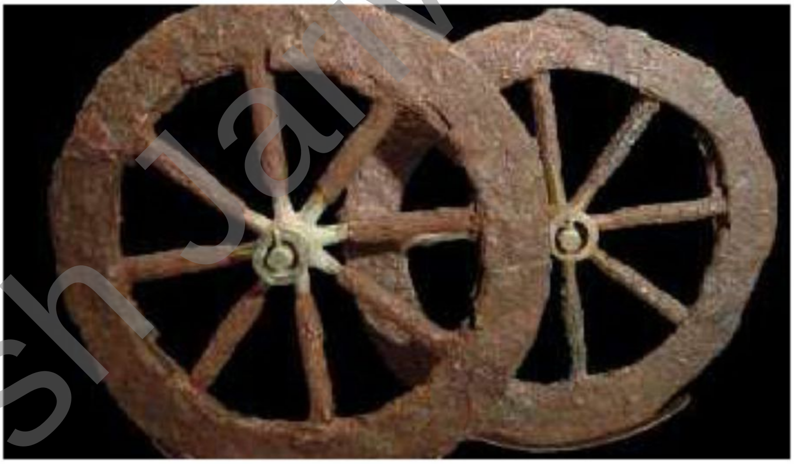
Above: A spoked wheel dated to the late 2nd millennium BCE, excavated at Choqa Zanbil, Iran



Above: Iron wheels with bronze hubs. Khorsabad, Palace of Sargon II, Neo-Assyrian period (721-705 BC)

THE ANCIENT NASHTIFAN WINDMILLS OF PERSIA

BLOWING IN THE WINDS

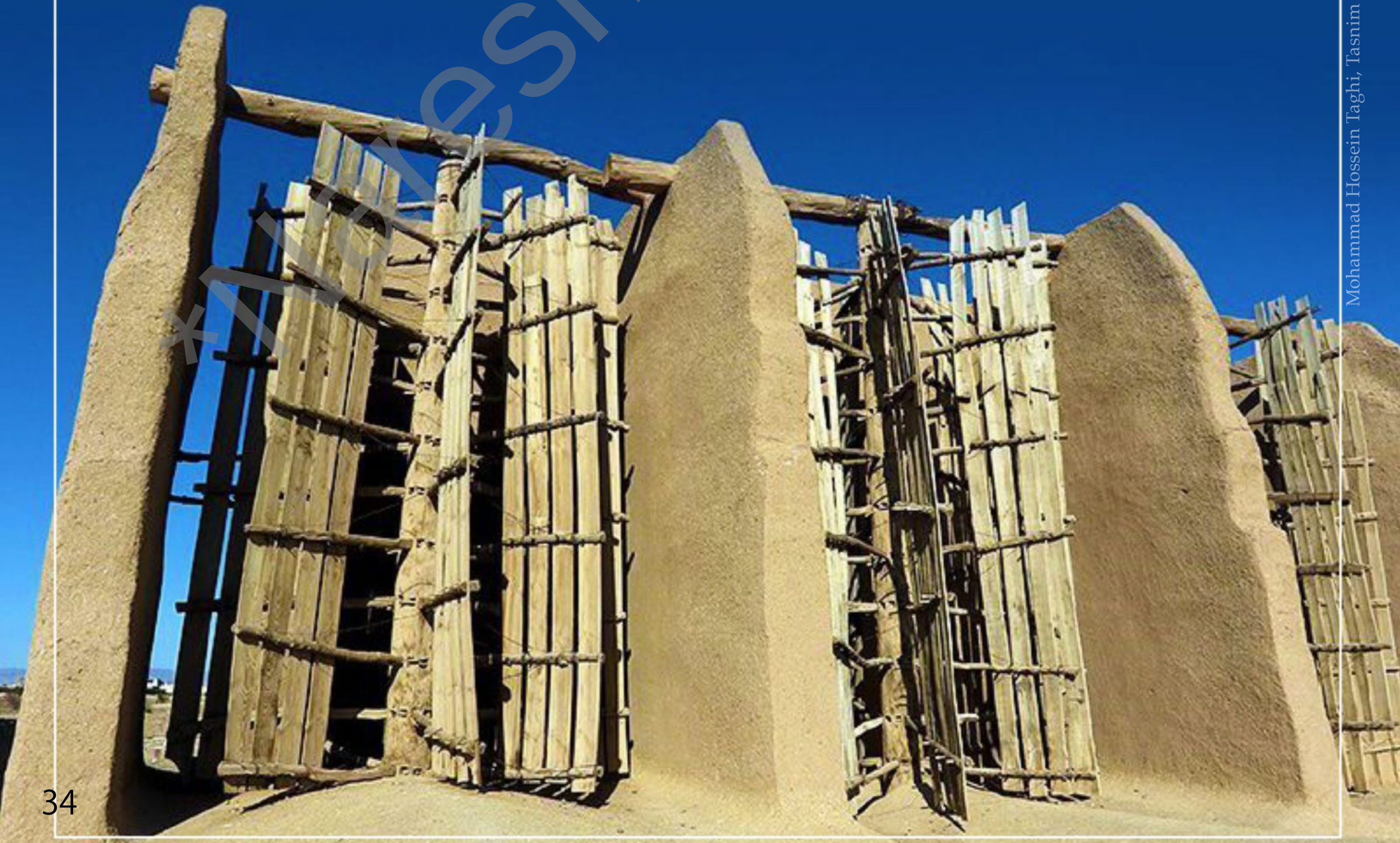
Wind has been used for centuries by humans to power machines that act as labor-saving devices, taking the effort out of an otherwise arduous task for mankind. One set of such machinery not only has been in existence for centuries, it has actually been functional since its construction.

Nashtifan is an ancient site located in Khaf County, north-eastern Iran. In antiquity, the town was known as 'Nish Toofan', which meant 'storm's sting'. Due to the strong winds of the area, windmills were built here to harness this source of energy.

The earliest known documented windmill design was developed in ancient Persia between 500 and 900 AD, known as a 'panemone windmill', or an '*asbad*'. There are about 30 asbad windmills at Nashtifan that have been used for milling grain into flour.

An asbad consists of a central vertical shaft, onto which are attached horizontal struts with sails made of reed or wood bundles and each windmill contains eight chambers. Each chamber, in turn, houses six blades attached to a central vertical shaft. As wind enters the chambers, the blades rotate, turning the grindstones that are attached to them. It's said these windmills have been functioning for about 500 to 1,000 years.

In 2002, the windmills of Nashtifan were recognized as a national heritage site by Iran. However, the progress made in technology means that there are now easier ways for people to grind grain, rendering the windmills obsolete. Currently, a man called Mohammad Etebari is in charge of maintaining the windmills of Nashtifan. Unfortunately, the windmills may soon stop turning, as Etebari has no successor among the youth. ■



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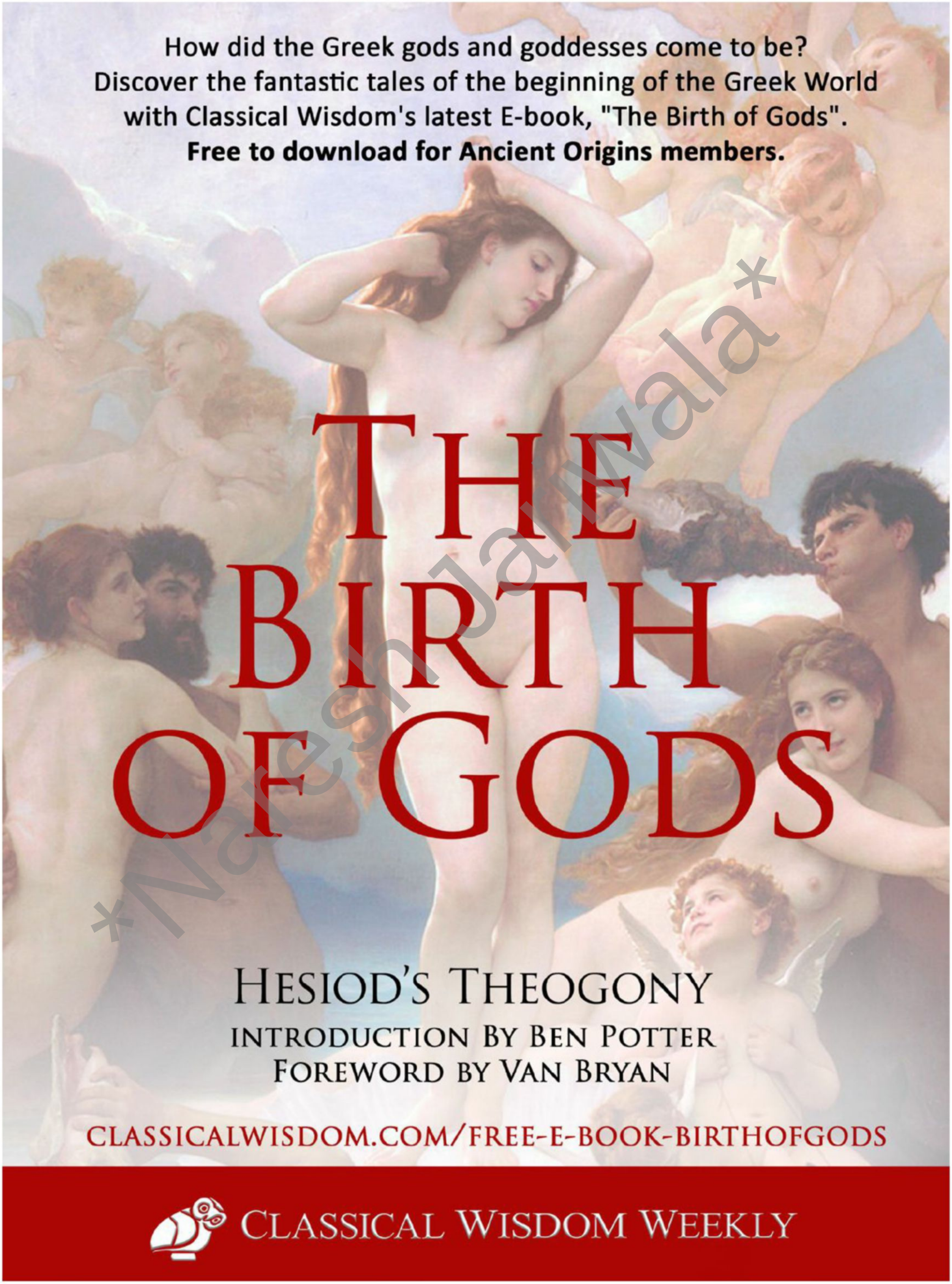

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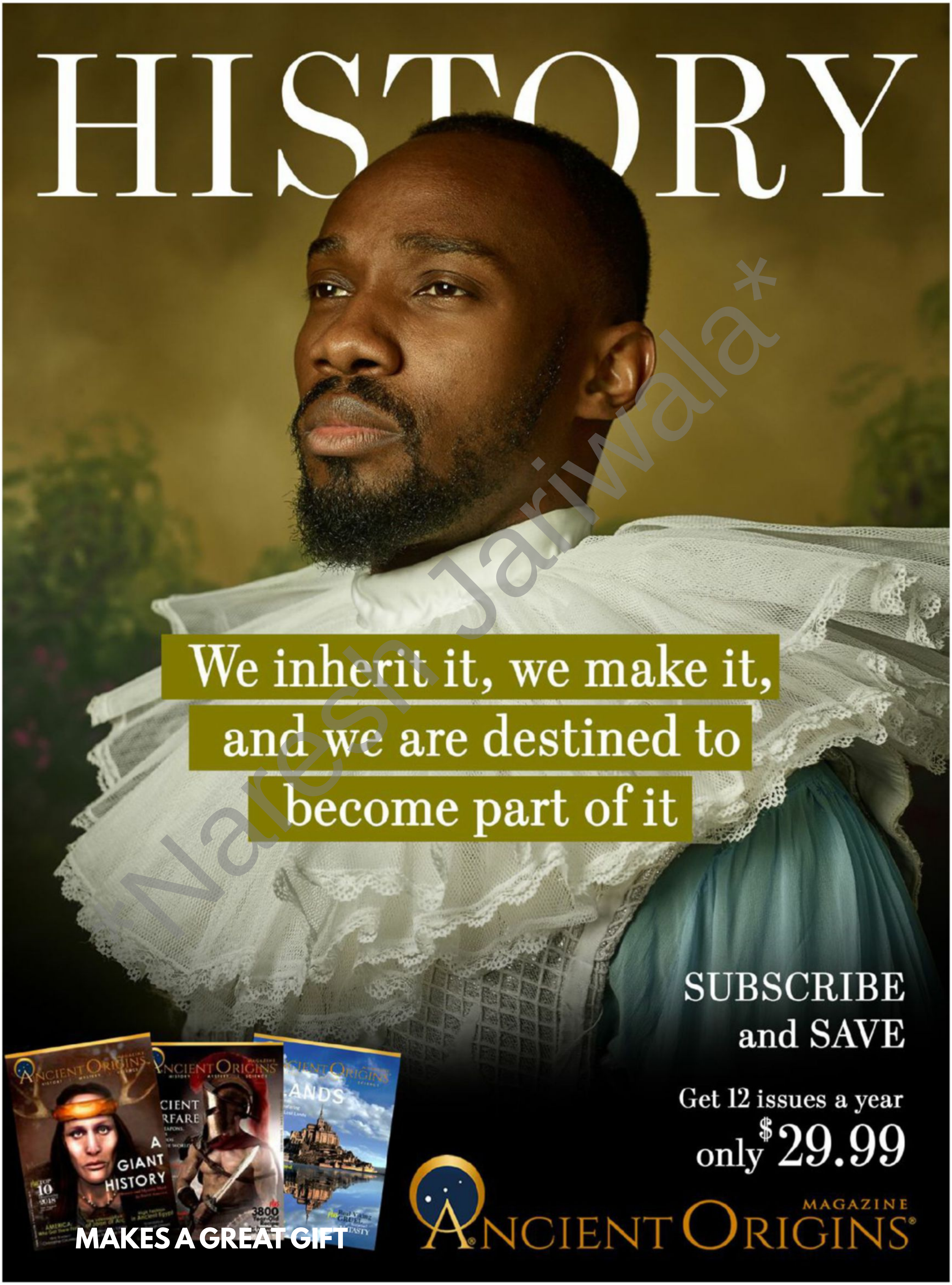
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THE MAN WHO STOPPED A DESERT

USING ANCESTRAL FARMING TECHNIQUES

BY WU MINGREN

Climate change is a major contributing factor in the desertification process, and simulations suggest the greenhouse effect may increase the spread of deserts by as much as 20 percent. Various measures have been taken to counter the detrimental effects, with some providing better results than others. An 80-year old farmer of Burkina Faso in West Africa looked to his ancestors and came up with an innovative solution.

Desertification has been defined as a process of land degradation in arid, semi-arid and sub-humid areas due to various factors including climatic variations and human activities. Modern innovations, as well as traditional practices to stop the negative impact of desertification, are officially termed agroforestry or farmer-managed natural regeneration, but Yacouba Sawadogo, a farmer in Burkina Faso, has no time for fanciful terms. He took the initiative to combat desertification in his country by using simple, traditional methods applied by his African ancestors.

TAKING MATTERS INTO HIS OWN HANDS

Burkina Faso is a landlocked country in western Africa. The northern area of this country lies within the Sahel, a semi-arid region sandwiched by the Sahara Desert in the north and the Sudanese Savanna in the south. Desertification has been a serious problem in the northern part of Burkina Faso since the 1970s. As a result of over-farming, over-grazing, and over-population, the soil in this region has suffered from heavy erosion and drying over the decades. Efforts have been made both on a national and international scale to remedy the situation, though to no avail.

Traditional huts in Burkina Faso

As a child, Sawadogo was a pupil at a religious school and often experienced hunger due to droughts, which motivated him to improve his circumstances and those of his fellow citizens. It was during the 1980s that Sawadogo, seeing the despair of fellow farmers and realizing that the measures taken by the authorities were not producing results, decided to take matters into his own hands. Sawadogo employed two traditional methods – *Zaï* and *cordons pierreux*, in his battle against the desertification of his country. As these traditional ways were regarded as odd by his community, Sawadogo was initially thought to have lost his mind and was ridiculed, but his innovative methods eventually spread over the continent, like an African bush fire.

TWO FARMING TECHNIQUES

Zaï is a farming technique that has been used traditionally in the western part of the Sahel, which includes Burkina Faso. In essence, this technique involves the digging of holes in soil that is not very permeable, so that runoff water can be collected. These holes have a depth that ranges from two to six inches, and a diameter of between six and 20 inches. Fertilizer or compost is placed in the holes to increase the nutrients in the soil. Besides leaves and ash, Sawadogo uses manure, which attracts termites whose tunnels help further break up the soil. Seedlings are then planted in these holes.

Sawadogo was initially thought to have lost his mind but his innovative methods eventually spread over the continent

The advantages of this technique are many. For instance, this is a simple and cheap strategy that may be utilized by any farmer. It is, however, a labor-intensive technique and, therefore, the cost is higher in terms of manpower.

Avaresh Jariwala*

Yacouba Sawadogo shares his techniques with farmers

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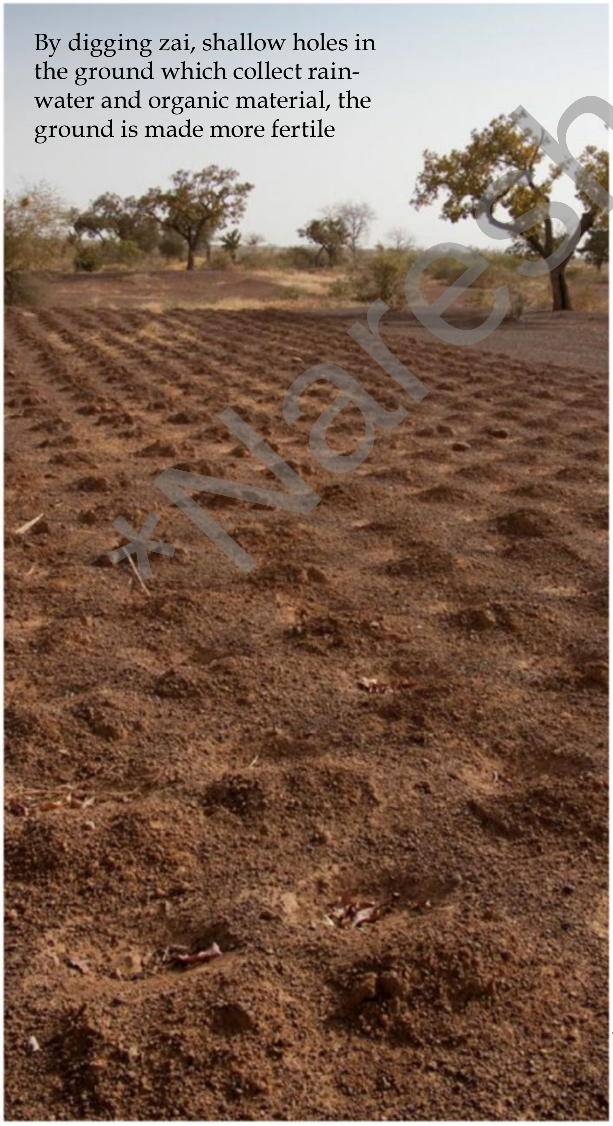
In addition, farmers need to monitor and maintain their Zaï holes. Luckily, Sawadogo has 27 children to assist him. The efficacy of Zaï is evident, as its use has resulted in increased crop yield. Zaï holes have improved the yields of trees, sorghum, and millet by up to 500 percent. A bonus to Sawadogo's forest is that it began attracting bees, so he set up hives for them. The honey has become an added source of income for him.

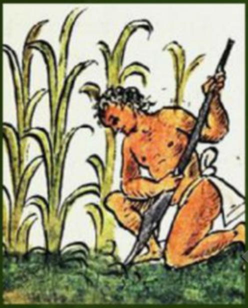
Another traditional technique employed by Sawadogo is known as *cordons pierreux.* While the Zaï holes collect runoff water, the cordons pierreux prevents the runoff water from going to waste by slowing down its flow. This technique uses fist-size stones that are arranged in a thin line across the field, which slows down the flow of runoff water and acts as a catchment area, thus allowing more time for the water to permeate the earth. The accumulated silt also provides a comparatively fertile spot for seeds of local plants to sprout.



By digging zai, shallow holes in the ground which collect rain-water and organic material, the ground is made more fertile

TreeAid/CC BY 2.0

Mystical
Aztec Floating Gardens



The Aztecs were in control of an empire of five to six million people, meaning agriculture was vital. To fill this need they used the chinampa system, so-called 'floating gardens' on shallow, Valley of Mexico lake beds. Chinampa agriculture was used throughout Mesoamerica centuries before the rise of the Aztecs, but their large population provided enough laborers to be especially successful with this method.

A chinampa plot was constructed by staking out a rectangular enclosure, about 100 ft. long by 10 ft. wide, into the marshy lakebed. The enclosure was fenced in by joining the stakes with wattle. After that, the fenced-in area would be filled with mud and decaying vegetation. In order to prevent the roots from becoming water-logged, it was important that the fill brought the chinampa plot above lake level.

The next plot would be parallel to the first, with a narrow canal for canoe passage left in between. The canals surrounding the plots formed an illusion that these agricultural lands were floating on water, hence its misattribution as 'floating gardens.'

During the rainy season, flooding was prevented through a sophisticated drainage system which included dams, sluice gates, and canals. And in the dry season, moisture was maintained by carrying water in containers from the canals to the plants.

Serge Saint/CC BY 2.0

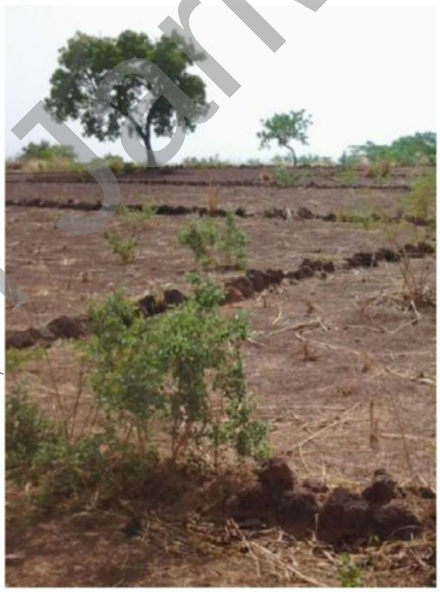
After the drying up of the Anahuac lakes, only Xochimilco and Tláhuac retain the chinampas

SUCCESS!

The success gained by Sawadogo in his fight against desertification has made him a respected figure in the community that initially ridiculed him. In 2010, a documentary film entitled *The Man Who Stopped the Desert*, about Sawadogo's life premiered in Norwich in the UK. This film showcased his work on the international stage and highlighted the problems he had faced, as well as the potential steps that may be taken by countries such as Burkina Faso to mitigate them. The fame Sawadogo had achieved through the film enabled him to reach out to a much greater audience and allowed him to share his agricultural techniques with fellow farmers, empowering them with more effective tools in their struggle against desertification.

Over a period of more than two decades, Yacouba Sawadogo's work with Zaï holes allowed him to create a forested area of 62 acres. He planted trees with medicinal properties since there are no clinics in the rural area, and he built huts which serve as a bush-hospital for the sick that flock to him to benefit from his natural plant remedies. In 2016, Sawadogo's good work was threatened by developers, who annexed parts of his land and carved it up into smaller plots. One plot contains the well he built 10 years ago, and another the graves where he buried his parents. He launched a campaign to try and raise the funds to buy back his land from the authorities.

Despite discouraging obstacles on a national front, Sawadogo received international acclaim in 2018 when he was awarded the Right Livelihood Award, to "honor and support those offering practical and exemplary answers to the most urgent challenges facing mankind today". Today, Sawadogo's project is facing another serious threat. Jihadist groups are launching insurgent attacks in northern Burkina Faso, leading to inter-communal conflict and social unrest. Only time will tell if Sawadogo will succeed in overcoming this obstacle too. ■



Le Soleil dans la Main/CC BY SA 4.0

Above: Reforestation in Burkina Faso

Left: Cordons pierreux to prevent water erosion; it slows the flow of runoff water and acts as a catchment area

Below: Tilling the land

Keeping COOL in the Desert with 2,400-Year-Old Fridges!

By Caleb Strom

Our ancestors did not have electricity, but they did come up with amazing technology. The *yakhchal* (meaning ice pit) was an ancient refrigerator built in the deserts of Persia (now Iran), made without electricity, modern coolants, or most elements of modern refrigerators.

This design of refrigerators was mastered by Persian engineers around 400 BC. Yakhchals are domed structures with an underground square-shaped containment area. After the containment area was dug and the dome was erected, a mortar made from clay, sand, ash, goat hair, and lime called sarooj was used to make it waterproof.

The collection area for the water needed to be deep enough to keep cool and the material out of which the yakhchal was made needed to be enough of an insulator to keep out heat. Water was brought to the yakhchal either by directly transporting ice from nearby mountains or diverting water from an aqueduct into the yakhchal using underground water channels called qanats. Adjacent to some yakhchals, an east-west oriented wall would be built on the south side of the refrigerator and water would be brought into the yakhchal from the north side of the wall. The reason for this was to keep the water cool during the middle of the day as it entered the yakhchal.

Another device used to keep the yakhchal cool is a *badgir,* a type of wind-catching mechanism, which would divert the breeze down into the yakhchal. As the air descended, it would be cooled by the ice as well as the cool air accompanying the water in the qanat.

Once in the yakhchal, the water would freeze overnight. This process could be expedited through having ice, transported from the mountains, already present in the yakhchal to act as a seed. Once the water was frozen, it would be cut up into blocks so that the water could be easily transported out of the yakhchal for drinking and other purposes. In addition to storing drinking water, the yakhchal was also used to keep food such as fruit, dairy products, and probably meat.

Many yakhchals in Iran, Afghanistan, and other parts of west and central Asia are still standing even after thousands of years. They represent the remnants of ancient Persia and are a part of the cultural heritage of Iran. Yakhchals have also been suggested as an inexpensive and sustainable way for modern Iranians and other central Asian communities to have access to refrigeration without requiring the use of electricity. A revival of this ancient technology could help modern people around the world live more sustainably and still have modern conveniences, specifically refrigeration. ■

Snow Houses

The native people of the circumpolar region, the Inuit, lived in sub-zero temperatures for much the year but survived and even thrived. In the winter, hunters built dome-like structures made from blocks of snow, called igloos, and they stayed warm enough to survive for days or months. Snow is used because the air pocket trapped in it makes it an insulator. On the outside, temperatures may be as low as −49 °F, but on the inside, the temperature may range from 19 to 61 °F, when warmed by body heat alone. The individual snow bricks start out four-sided and are cut out of the ground with saws and machete-like blades, but are then often cut into five or six-sided shapes to increase structural interlocking, similar to the stones used in the Inca Empire.

Igloo in the north. Ivan Kmit|AdobeStock

MADE IN

8 Ancient Chinese Inventions That Changed the World

By Micki Pistorius

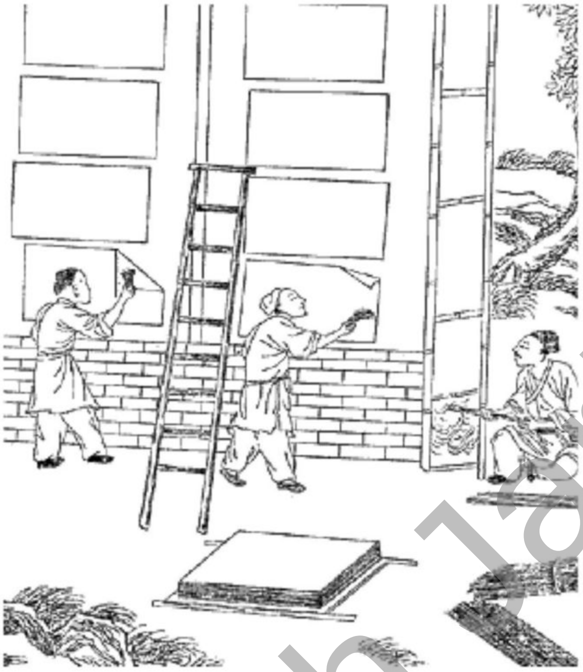
Ancient China was one of the oldest and longest-lasting civilizations in the history of the world. It also boasts the largest number of inventions that have influenced our world today, including the Big Four – the compass, gunpowder, paper, and printing.

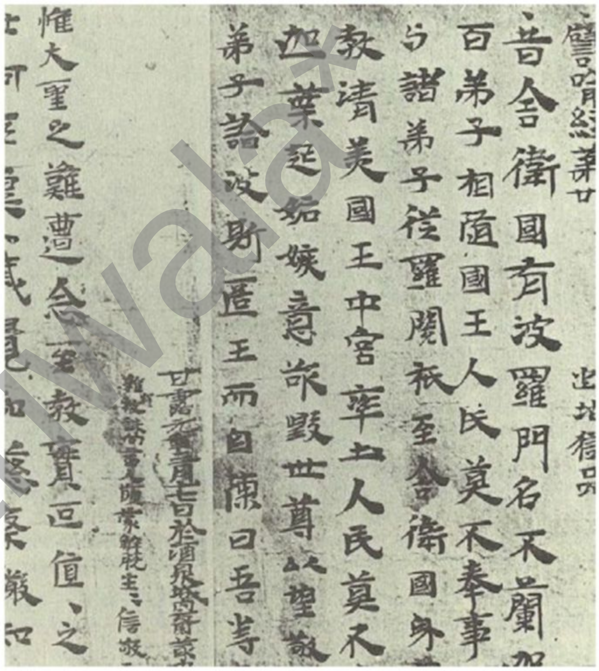
They created dozens of things without which our lives wouldn’t be the same today, including inventions in metallurgy, astronomy, agriculture, engineering, mechanics, hydraulics, craftsmanship, and warfare. From umbrellas to wheelbarrows, and many things in between, our lives have been made immeasurably easier thanks to the innovations of the ancient Chinese.

Eight is considered the luckiest number in Chinese culture because it sounds like fa, which means “wealth”, “fortune”, and “prosper” in Chinese, so we decided to highlight eight of the best ancient Chinese inventions.

> China boasts the largest number of inventions that have influenced our world today, including the Big Four – the compass, gunpowder, paper, and printing. Believe it or not - they even invented the fork!

N CHINA





Above: Papermaking in ancient China

Oldest surviving book on paper, 250 AD

#1

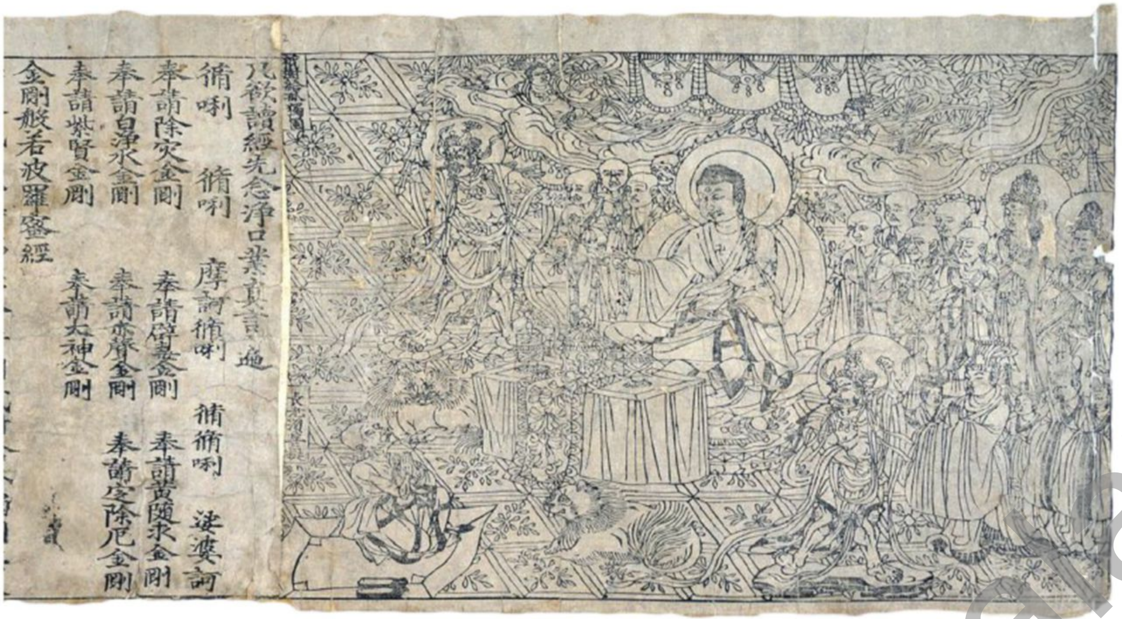
PAPER

For millennia men used clay tablets to record inventories. The Egyptians were the first to produce papyrus around 3000 BC, however the Chinese – specifically Cai Lun, a eunuch in the Han dynasty - invented paper in about 105 AD, although a paperchase may lead back to its origins in the second century BC.

Paper is of course much more convenient than clumsy clay tablets, especially if it is to be used as toilet paper. Already in the ninth century, during the Tang dynasty, people began using toilet paper and by the time of the Ming dynasty (1368 – 1644), the members of the imperial court used toilet paper for their delicate royal derrieres regularly. It was not until the mid-19th century that toilet paper became popular in the West, after Joseph C Gayetty had practiced some industrial espionage and ‘borrowed’ the invention from the Chinese.

Once the trade routes had been opened by pioneers, China became – and still is – a prolific trade center. Transporting ingots and coins long distance could be cumbersome and dangerous, so by the ninth century China came up with another great idea – almost as important as toilet paper – and that is to exchange notes for coins, which as we all know, eventually became printed money.

Foreign traders had to eat and frequented Chinese restaurants, but they could not understand cooks or ‘waiters’ so by the era of the Song dynasty (960–1279), the Chinese presented menus on paper explaining the delicious dishes.



凡欲讀經先念淨口業真言遍
脩唎 脩唎 摩訶脩唎 脩脩唎 娑婆訶
奉請除災金剛 奉請辟毒金剛 奉請黃隨求金剛
奉請白淨水金剛 奉請赤聲金剛 奉請定除厄金剛
奉請紫賢金剛 奉請大神金剛
金剛般若波羅蜜經

A page from the Diamond Sutra, printed in the 9th year of Xiantong Era of the Tang Dynasty, circa 868 AD

#2

PRINTING

Perhaps menus were created by hand, but banknotes had to be produced in bulk, which gave rise to printing. During the Tang Dynasty, in 868 AD, woodblock printing was used to print "*The Diamond Sutra*", considered to be the very first book printed on paper of a regular size.

Initially, a text in its entirety would be carved onto a wooden block in reverse. Ink would be spread over the block and it would then be turned around and pressed onto the paper. One wooden block could produce about 20,000 sheets of printed copies. In the 10th century, an inventor called Bi Sheng borrowed from the age of clay tablets, and produced individual letters on baked clay pieces, to be arranged on an iron plate to form different words. Again, like the toilet paper, this technique was copied centuries later in the West when Gutenberg printed the first Bible in the 1450s.

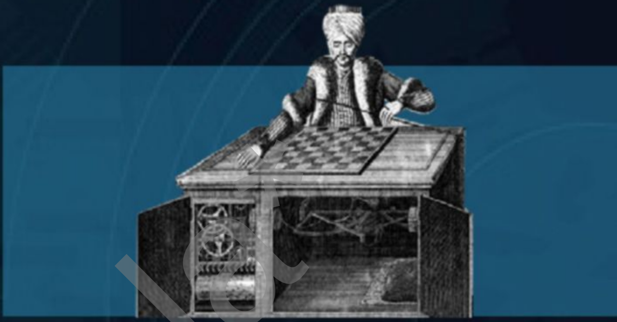
#3

ALCOHOL

Give that man a Baijui! China's favorite distilled alcoholic beverage is called baijiu. But before we raise our glasses to the chap, let us remember it was a woman actually, Yi Di, the wife of the Emperor Yu the Great of Xia, who brewed her husband an alcoholic beverage around 4,000 years ago. Many wives today may question the wisdom of this queen's ingenuity! However, research by the University of Pennsylvania indicates that the Chinese had mastered the skills of fermentation and distillation about 9,000 years ago, so Mrs. Yu is let off the hook.

Baijiu, traditional Chinese alcohol

AMAZING ANCIENT ARTIFICIAL INTELLIGENCE?



When the dark magician was wheeled out before the audience, a hush fell over the court of Empress Maria Theresa of Austria. It was 1770, and inventor Wolfgang von Kempelen boasted that no human would be able to defeat the magician at his game – chess.

Kempelen carefully wound a mechanism in the device, and when the sorcerer lifted its silver gaze, and raised its hand—seemingly impossibly—the crowd cried out in shock, amazement, and horror.

The mechanical 'Turk,' as it became known, went on to defeat all challengers in the game of chess, including experts, royals, statesmen, and sharp intellects, such as Benjamin Franklin and Napoleon Bonaparte.

Looking like an amazing, ancient form of artificial intelligence, it is now said the astonishing machine was instead a clever 18th-century hoax, as it was not fully autonomous but an ingenious deception; a blend of machine and man.

Experts suspect that the cabinet held small men who were experts in chess, and they remained hidden within the cabinet, creating an astounding illusion. It's believed somehow, that without detection, these men operated the movements of the Turk and defeated all players. As the Turk was destroyed in a fire July 5, 1854, we'll never know the truth.

#4

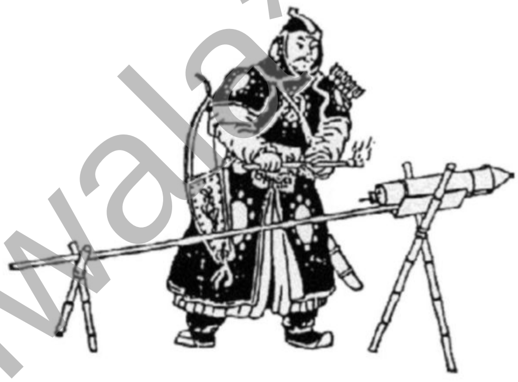
ROCKETS

Stand back NASA and Roscosmos – here comes China. Long before America and Russia competed in the space race, the Chinese had already invented rockets by the third century AD. Although very primitive at first - stuffing a paper tube with gunpowder (another Chinese invention) and attaching it to an arrow to be shot with a bow – this invention eventually led to sophisticated spacecraft and... Chinese fireworks, which we all enjoyed 15 days ago on New Year's Eve.

#5

FORKS

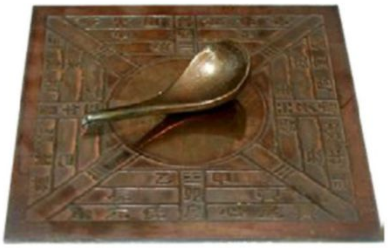
Everyone knows how difficult it is for foreigners to acquire the skill of eating with chopsticks, so one would imagine that it was a Western trader in one of those ancient Chinese restaurants of yore, who invented a fork out of sheer desperation or hunger. Yet this is another invention of the Chinese that never quite took off in China! Qin Shi Huang, the first emperor of China even took one to his grave, probably knowing he would have an eternity to figure out how to use it instead of chopsticks.



#6

COMPASS

How often does one hear that someone 'went off to find himself'? Everyone seeks direction in life and the practice of consulting fortune tellers or astrologers was as popular in antiquity as it is today. Yet, who would have thought that it was fortune tellers in third century BC China who first used a compass? Its value as an actual naval navigational device, instead of relying on astronomy, only caught on during the Song dynasty (circa 10th century AD). The device was eventually introduced to the West by Arab traders and travelers, who managed not to get lost on the way, as the traditional Chinese compass indicated true South and not true North! The reason was that the needle was made from Lodestone, which naturally always points South.



Wikimedia Commons

Model of a Han Dynasty (206 BC–220 AD) south-indicating ladle or sinan. It is theorized that the south-pointing spoons were magnetized lodestones

#7

IRRIGATION

The Chinese began cultivating rice about 4,000 to 3,000 years ago and it has become a staple in their diet. All those rice fields needed to be watered.
By about 200 BC, Chinese engineer Li Bing harnessed the flooding of the Minjiang river by creating an artificial levee and constructing a channel through Mount Yulei to redirect the excess water to the dry Chengdu Plain. Besides draining the floodwater, this irrigation system called Dujiangyan, watered almost 700,000 hectares of farmland, and still provides water to more than 50 cities in the Sichuan province today.

#8

SILK

China is most famous for its silk and the Silk Road opened up trade between East and West. As the trade in silk brought the ancient Chinese much revenue, they were determined to keep this knowledge to themselves and guard it as a state secret. But secrets leak and sericulture (silk farming) reached the Korean peninsula around 200 BC, and in India, silk farming is reported to have been established shortly after 300 AD. Silkworms were only smuggled to the West in the mid-sixth century by two monks at the behest of the Byzantine emperor Justinian I.

One of the most famous stories about the smuggling of this highly-prized knowledge out of China can be found in Procopius' *History of the Wars*. According to the archaeological evidence, silk was produced in China at least as early as the Longshan period (3500 – 2000 BC), and that the silk moth, Bombyx mori, was domesticated from the wild silk moth, *Bombyx mandarina*, around this time as well.

It is unlikely that we will ever know for certain how silk production was first discovered. According to the Chinese, this discovery, like many others, was an accident, and not deliberately sought after. The central figure of this tale is Leizu, the wife of the Yellow Emperor, a legendary ruler of China who lived during the third millennium BC.

In one account of the story, Leizu used her finger to touch a part of the silkworm cocoon, which caused a filament to come loose. She then began to wrap this filament around her finger. At the end of it, she found that it was a silkworm that made the cocoon, hence the discovery of silk.

In another tale, Leizu is said to have found some silkworms eating the leaves of a mulberry tree and spinning cocoons. She collected some cocoons and then proceeded to have a cup of tea. While she was sipping her tea, Leizu accidentally dropped a cocoon into the cup. The heat from the tea caused the cocoon's filament to loosen, which Leizu realized could be unwound and turned into thread.

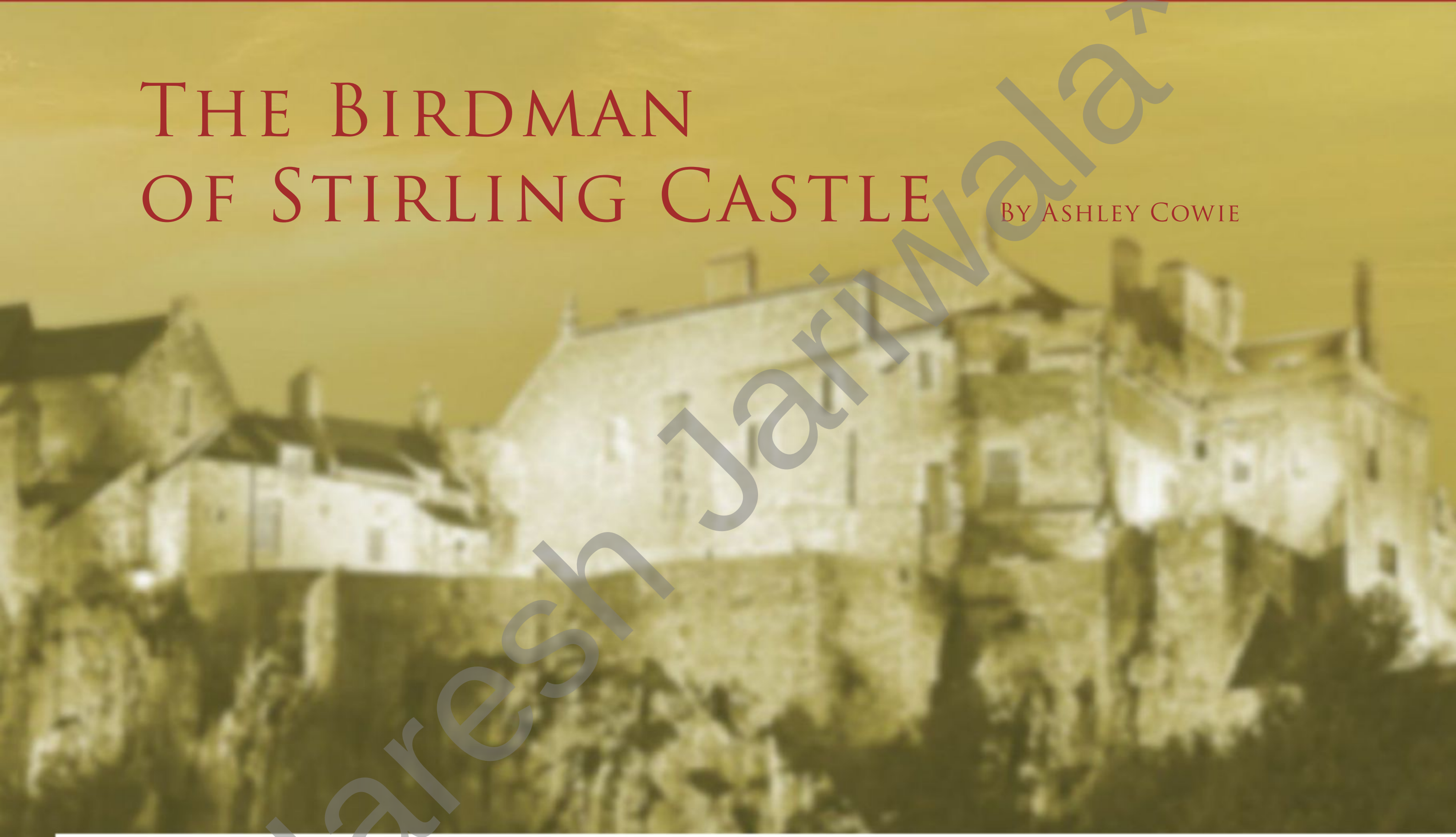
Leizu then persuaded the Yellow Emperor to provide her with a grove of mulberry trees so that she could domesticate the silkworm. Apart from this discovery, Leizu is also credited for the invention of the silk reel, a device that joined the silk filaments into a thread, as well as the silk loom, which was used to weave the silk threads into cloths.

Whether Leizu had a real role in the story of Chinese silk or not, the luxurious fabric certainly made her homeland very well-known. ■

Ancient Tech Gone Wrong!

The Birdman of Stirling Castle

By Ashley Cowie

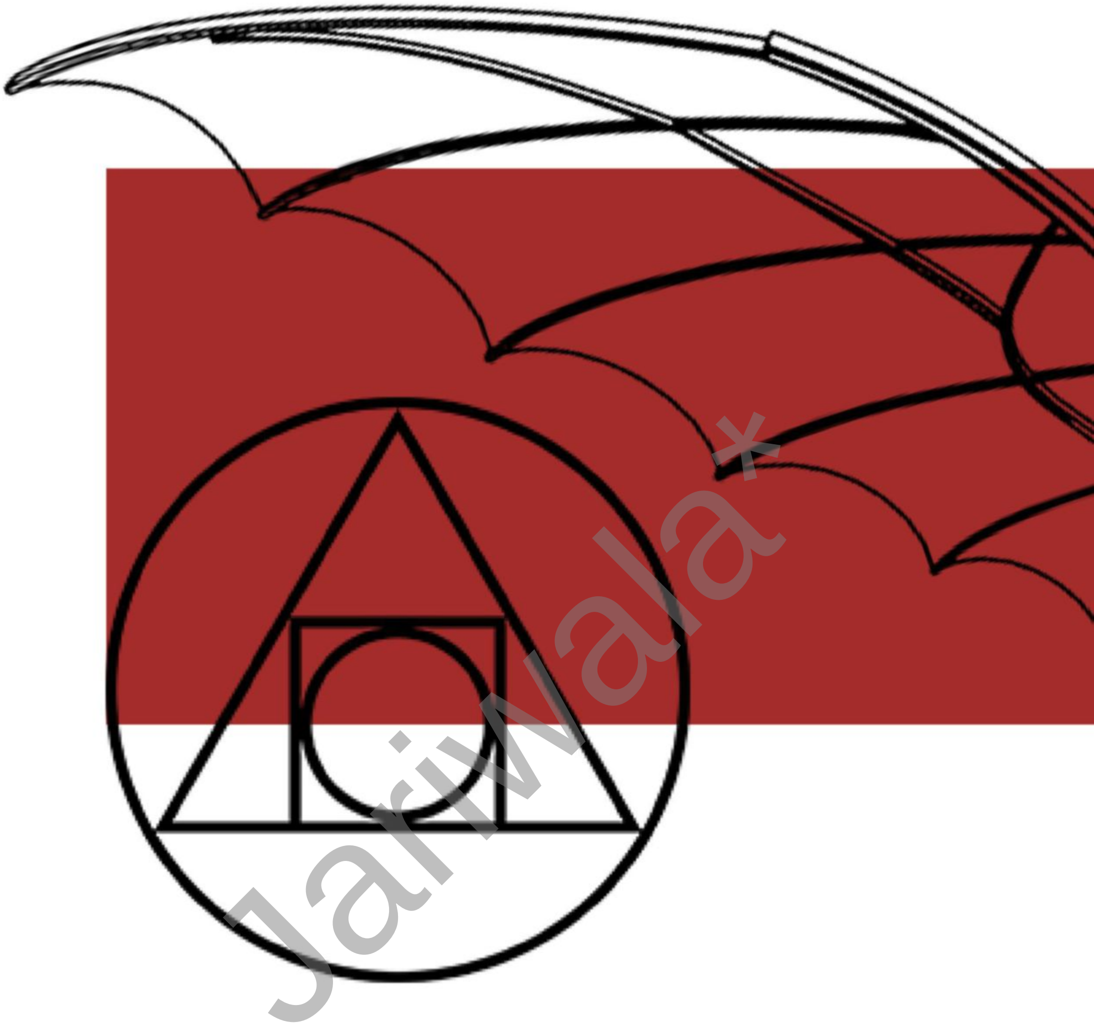


History books are peppered with stories of medieval European Alchemists attempting to turn base metals into gold and to produce elixirs of immortality. However, there was one disastrous alchemical experiment that was only ever attempted once, so far as historic aviation records go. This dire attempt at ‘alchemical flight’ in medieval Scotland led to the legendary pilot becoming known as The Birdman of Stirling Castle.

This bizarre story begins when a penniless Italian-born cleric by the name of John Damian de Falcuis, found his way to the city of Stirling in Scotland at the end of the 15th century. John was bereft of cash but loaded with charm, evident in that he was recorded as “attending the royal court of James IV of Scotland” at the beginning of the 16th century.

THE PROMISE TO THE KING

John promised the king inexhaustible supplies of gold and that he could produce enhanced medicines with secret Italian alchemical processes. A January 1501 record at the Scottish exchequer informs “John became the protégé of King James IV” and received a “great deal of money and other items from the king, to make the quintessence the elusive ‘Fifth Element’. With this money “Master John, the French Leech (physician) directed the building of alchemical furnaces at Stirling Castle and Holyroodhouse.”



The beginning of the 16th century in Scotland saw a surge of interest in science, and John’s promise of delivering the elusive ‘Fifth Element’ must have been highly valued. Rumors preceded John that Italian alchemists had made significant advances in alchemy and somewhere between 1501 and 1508 his mesmerism caused him to inherit the powerful position of Abbot of Tongland. What exactly was this ‘Fifth Element’ that John, and thousands of alchemists before him, attempted to create?

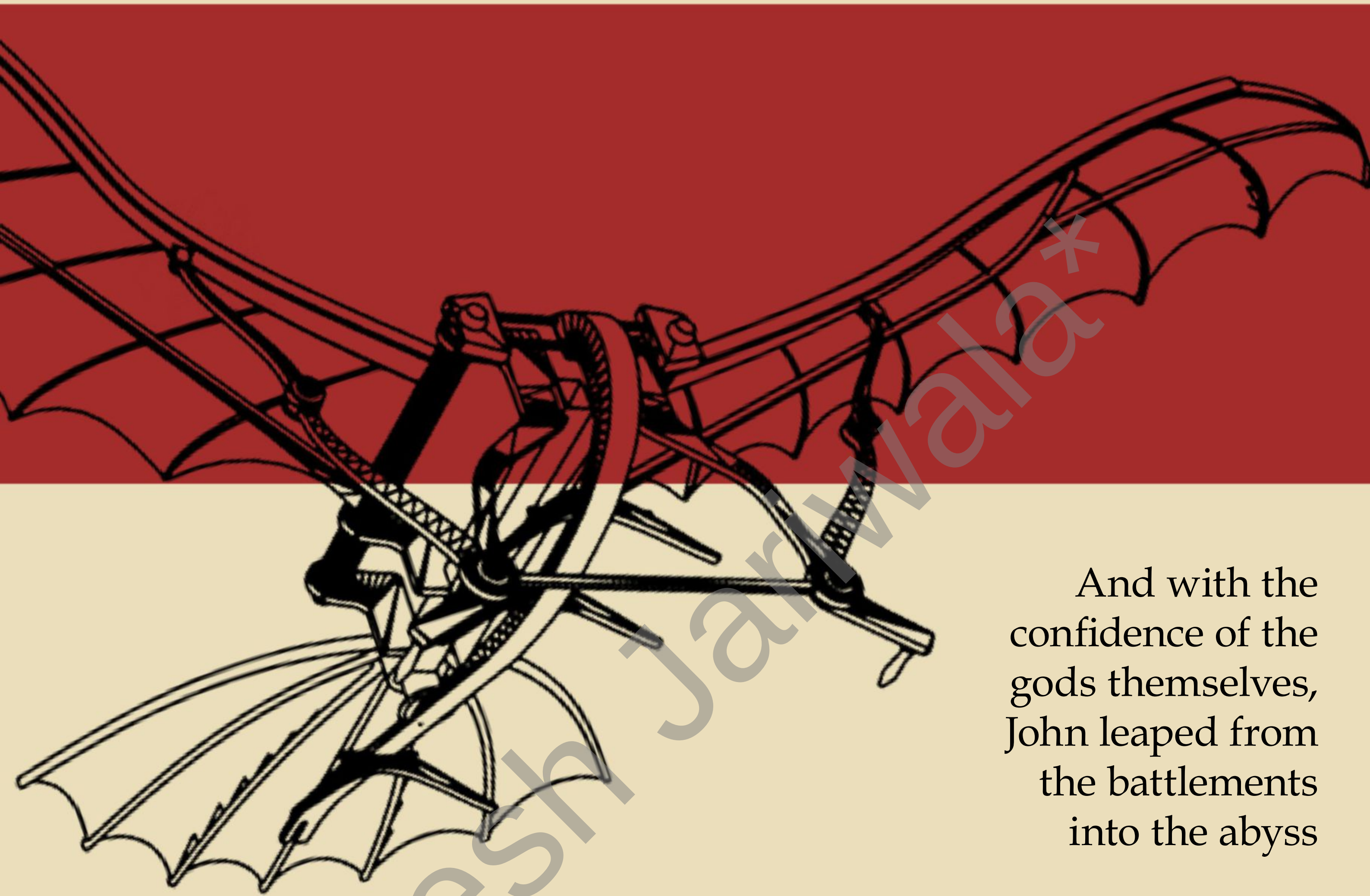
Alchemists believed that the Supreme Architect of the universe divided itself into the four elements; Fire, Earth, Air, and Water, which when added to Ether, formed the Quintessence of Matter - the ‘Fifth Element’. This union of the four elements was reflected in the 17th-century alchemical symbol of the square, two circles, and triangle, illustrating the interplay of the four elements of matter, which together symbolize what is variably referred to as the ‘Philosopher’s Stone’, ‘The Elixir of Life’, ‘The Kings Element’, or the ‘Fifth Element’ - the synthesis of alchemy.

The specific alchemical ingredients that John ordered to prepare his ‘Philosopher’s Stone’ at Stirling Castle are given on page 220 of Eric Holmyard’s 1957 book *Alchemy.* From the king he was given: “aqua vitae, quicksilver, sal, ammoniac, alum, litharge, orpiment, saltpeter, silver, sugar, sulfur, tin, verdigris, vinegar and white lead.” Notwithstanding, John failed to produce the ‘Philosopher’s Stone’ and neither did he deliver any gold.

ALCHEMICALLY ENHANCED FLYING MACHINE

In what appears to be a desperate, bordering on a maniacal attempt to save his name, John performed an extreme stunt directed at silencing his critics - which required that he put his own life on the line. In the autumn of 1507, alchemist John boldly declared to the king that his understanding of the elements would enable him to “fly to France” using a pair of artificial gravity-defying, alchemically enhanced wings, that he had invented.

For the next 48 hours, Stirling’s very best proto-aeronautic engineers hastily built John’s feathered flying rig. Scarcely two days after his promise of flight, he presented himself to the king and his courtiers, all assembled on the battlements of Stirling Castle. The flying device was built using “feathers supplied by the royal poulterers” and with the confidence of the gods themselves, John leaped from the battlements into the abyss.



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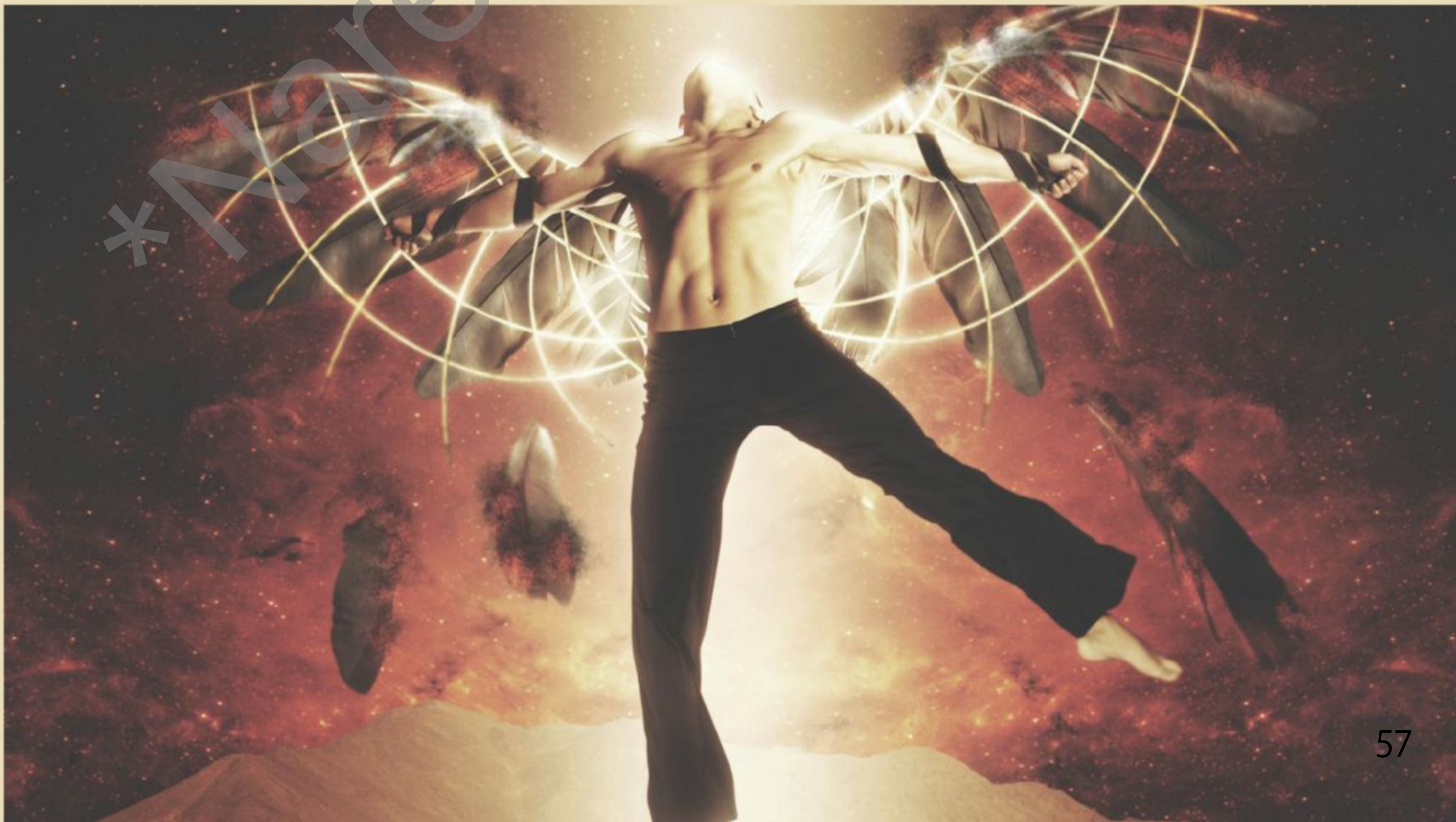


Now, if you have ever been in a car crash you will know all too well that time seems to slow down before impact, and that must have happened to John that evening in Stirling. For a split second that must have lasted forever, John was projecting outwards from the castle battlements and with his chin firmly forward he had a very successful take off, but before he could get his "wheels up", John plummeted to earth and landed in an undignified heap in a fresh dung pile some way below the castle.

> He had a very successful take off, but before he could get his "wheels up", John plummeted to earth

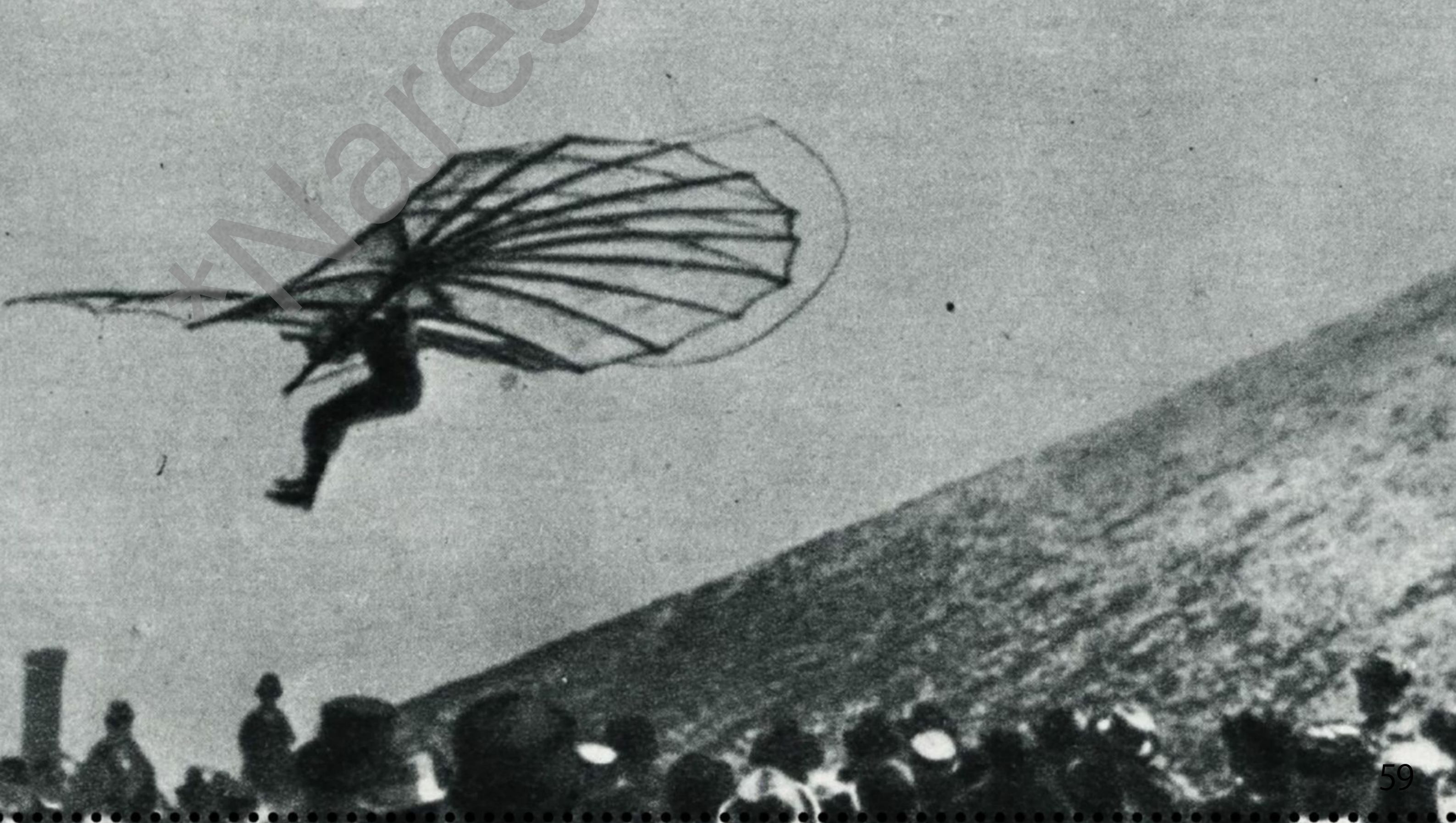
The following afternoon John awoke in a hospital with various injuries, (including a shattered thigh bone), and surrounded by a team of high-ranking clergy who pressed him to resign his prestigious title of the Abbot of Tongland. John's failed alchemical efforts to produce the 'Fifth Element' and especially his doomed flight, were immortalized in a satirical poem by William Dunbar entitled *A Ballad of the False Friar of Tongland, How He Fell in the Mire Flying to Turkey*: "John failed to make the alchemical quintessence" so he flew to Turkey, but because birds plucked his wings John "landed up to his eyes in a mire." That last bit was true.

John Damian de Falcuis, The Birdman of Stirling Castle, like so many historical figures in Scotland who dared to stick their head above the parapet, has received much criticism and ridicule, but to some, he remains a lovable rogue, a trickster, a magician, a conman, and the quintessential Medieval player. It was as a result of admiring these less sinister qualities that John Leslie, the Bishop of Ross, a later 16th-century chronicler, blamed John's failed flight on the fact that "he used chicken feathers" being unable to collect a "sufficient number of eagle feathers," which apparently John insisted that he needed before he made his doomed flight!

If John had only just given his idea of a flying device a little more development time, he might have achieved what Otto Lilienthal the "Flying Man" of Germany did in 1891, when he became the first person to make controlled untethered glides routinely. If John hadn't been in such a rush to quell the flames of his critics, today, the grandfather of the first hand-gliders, bat-wings, monoplanes, and later biplane forms mightn't be Lilienthal the "Flying Man," but de Falcuis, The Birdman of Stirling Castle. ■

Karl Wilhelm Otto Lilienthal was a German pioneer of aviation who became known as the “flying man”. He was the first person to make well-documented, repeated, successful flights with gliders.

Lilienthal in mid-flight, c. 1895

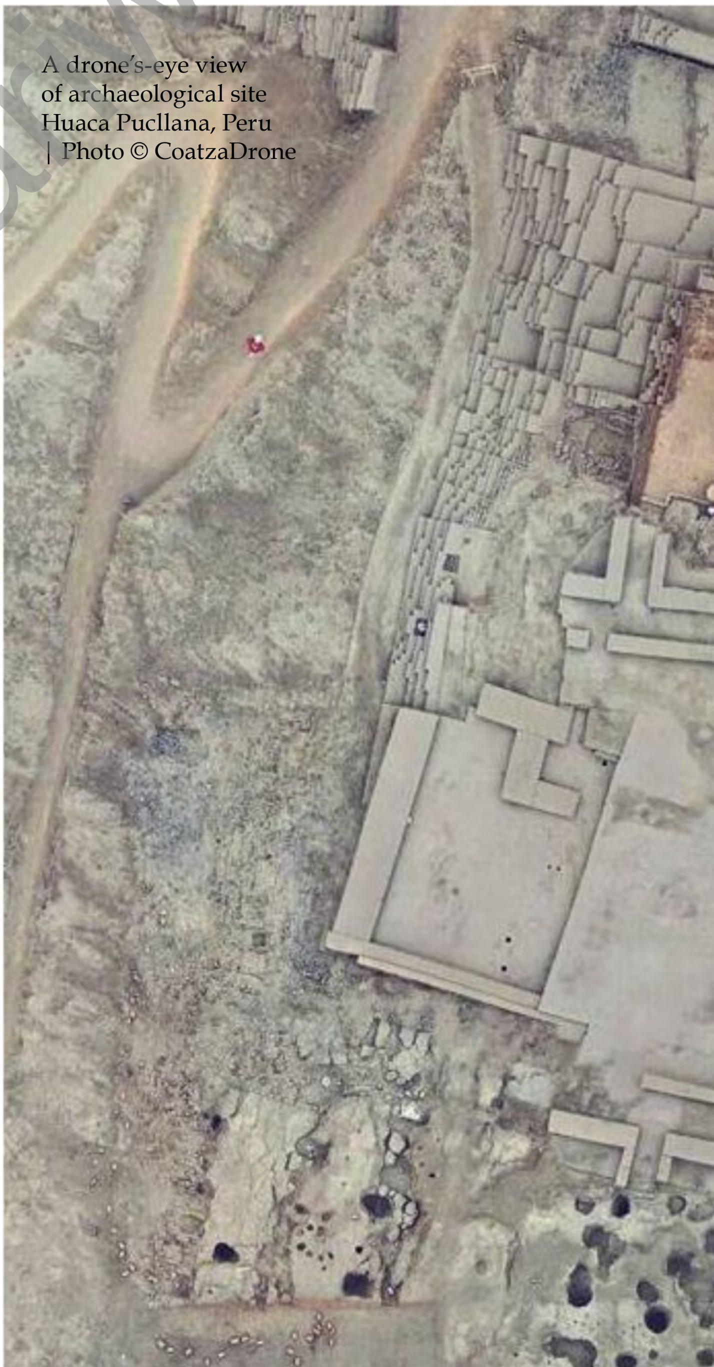


Naresh Parivala

Peruvian Archaeology Takes Flight with Drones

Modern Tech Meets Ancient World

Interview with Álvaro Ruiz Molano
By Joanna Gillan



A drone's-eye view of archaeological site Huaca Pucllana, Peru | Photo © CoatzaDrone

Neelesh Jariwala

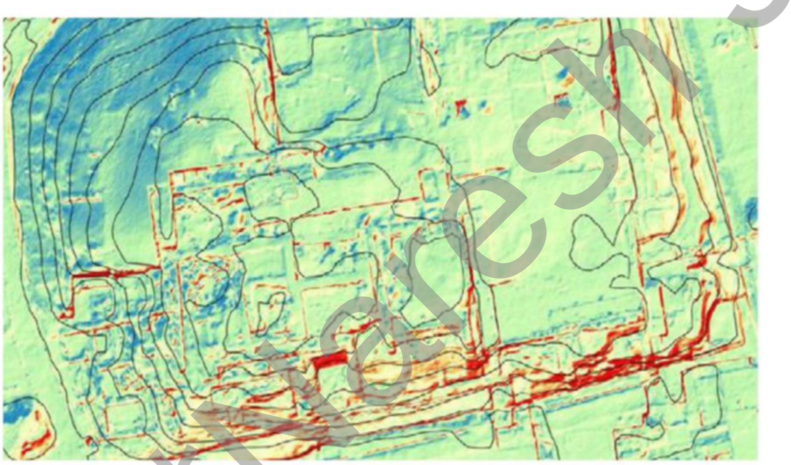
Archaeologists around the world, who have long relied on the traditional tools of their profession, like shovels, trowels, brushes, and buckets, are now turning to modern technology, such as LIDAR (remote sensing system) and drones, to protect and investigate archaeological sites. Nowhere has this become more apparent than in Peru, where the Ministry of Culture's drone team has mapped more than 600 sites to monitor and safeguard the country's ancient treasures. Here, we talk to Álvaro Ruiz Molano, Chief Operating Officer and Founder of CoatzaDrone, a Mexican-based company that has been applying the latest drone technology at archaeological sites in Peru and elsewhere across Latin America.

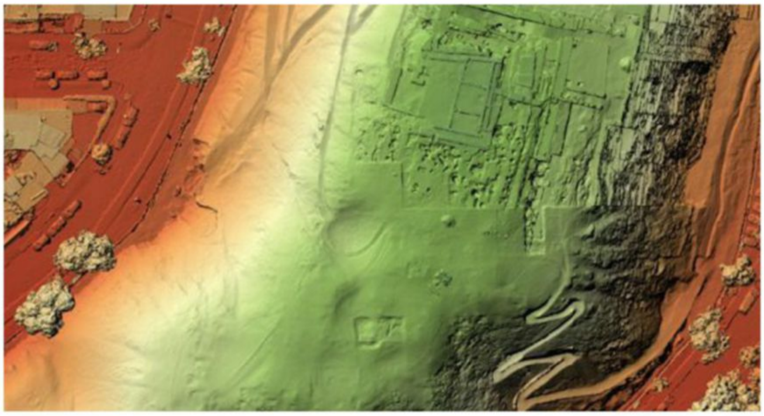
What are the different technologies you use to survey archaeological sites?

When studying archaeological sites, we mainly use digital photogrammetry with images acquired by drones, satellite images, scanning equipment, and image processing through the use of professional photogrammetric software such as Pix4D.

How can drone technologies be used for conservation and educational purposes?

Lately, drones have been used for archaeological conservation and educational purposes to document, analyze, and create 3D models of sites. In combination with other technology and software, drone data can help to create point clouds, contours, digital models of the surface and terrain, and orthomosaics [aerial image of an area, composed of multiple photographs stitched together]. This can be used to build a digital collection of data for heritage recognition, blueprints, and when planning or embarking on projects at archaeological sites.





Drone imagery of sites in Peru
| Photos © CoatzaDrone

Naresh Jaiwala

On site at Huaca Pucllana, Peru | Photos © CoatzaDrone

DRONE COATZA

Created in May 2014, CoatzaDrone is a company of highly skilled professionals with experience in various sectors who have opted for the newest technology, making them pioneers in the implementation of these systems in Mexico. They provide photogrammetry, photography, and aerial video services to several industries, such as construction, energy, mining, agriculture, the environment, archaeology, heritage, and security. CoatzaDrone has completed projects across Latin America and collaborated with universities in Mexico, Peru, and Chile, as well as with private companies.

coatzadrone.com

One of the main focuses of your team has been on the huacas in Lima, Peru. Can you tell us a bit about the huacas and why they are important?

Huacas were religious centers that have become famous because people used to leave offerings there. That's also why they were often looted in the early years of the Spanish invasion of Peru (in the 16th century). 54 huacas can be found across the city of Lima alone and most are more than 4,000 years old, being built in pre-Inca times; however, a few are from the Inca period. This is why Lima can be classified as a "millennial city." Most of the huacas are surrounded by modern buildings, except for a few which are not in populated areas.

Huaca Pucllana is one of the most researched archaeological sites in Lima. How will your work at this site add to what is already known? What new information might the drone technologies provide?

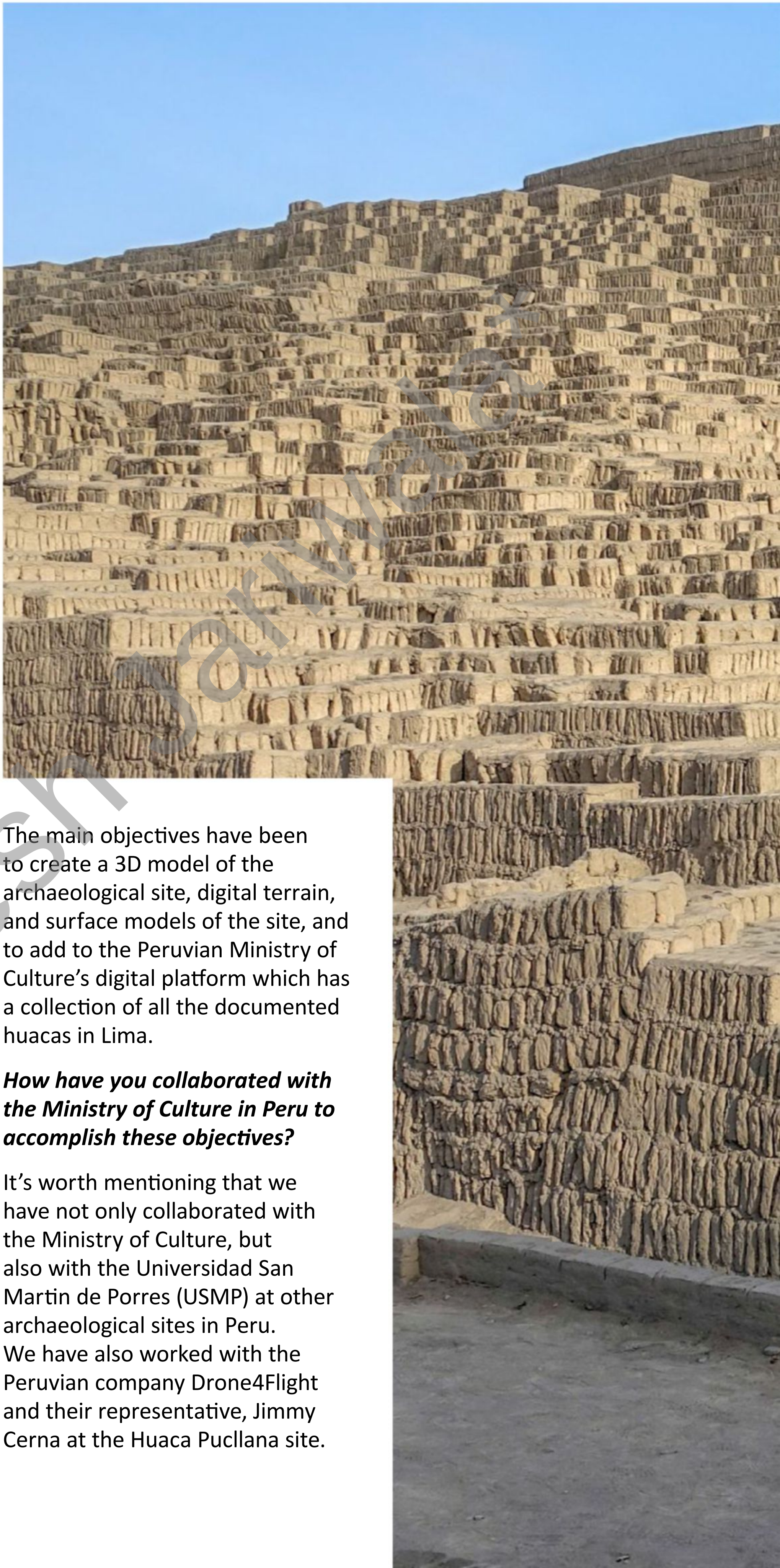
The digitalization of archaeological sites such as Huaca Pucllana helps because there is a digital 'backup' of what a site looks like in case of its destruction during a natural disaster. This also means that there is a digital database containing radiographical information about the terrain, which could be useful for future archaeological excavations and projects at a site. It also provides precise technical information about sites, which can help archaeologists and other experts when making decisions on how to best interact with a site.

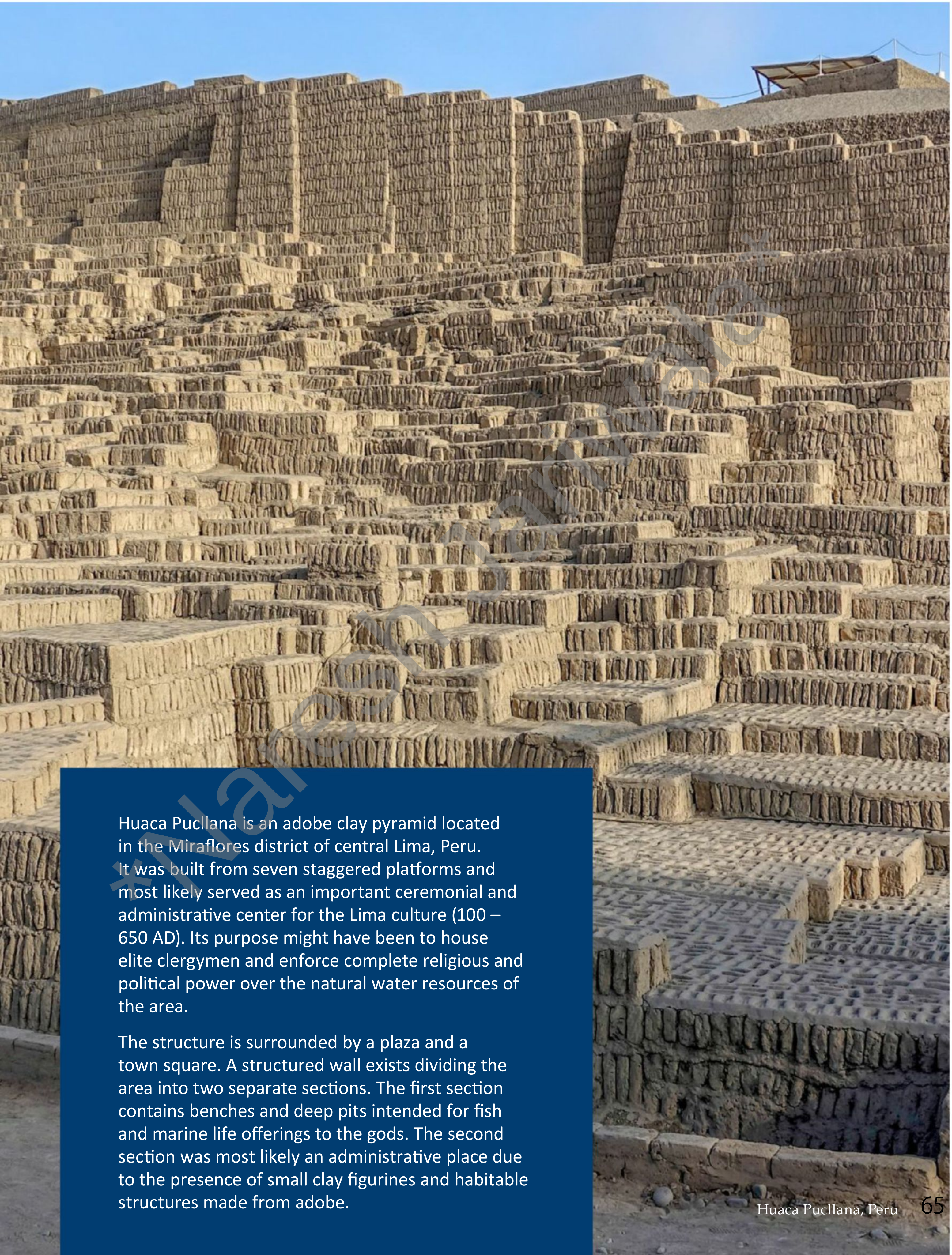
What are the main objectives of the surveys you have carried out at Huaca Pucllana?

The main objectives have been to create a 3D model of the archaeological site, digital terrain, and surface models of the site, and to add to the Peruvian Ministry of Culture's digital platform which has a collection of all the documented huacas in Lima.

How have you collaborated with the Ministry of Culture in Peru to accomplish these objectives?

It's worth mentioning that we have not only collaborated with the Ministry of Culture, but also with the Universidad San Martin de Porres (USMP) at other archaeological sites in Peru.
We have also worked with the Peruvian company Drone4Flight and their representative, Jimmy Cerna at the Huaca Pucllana site.

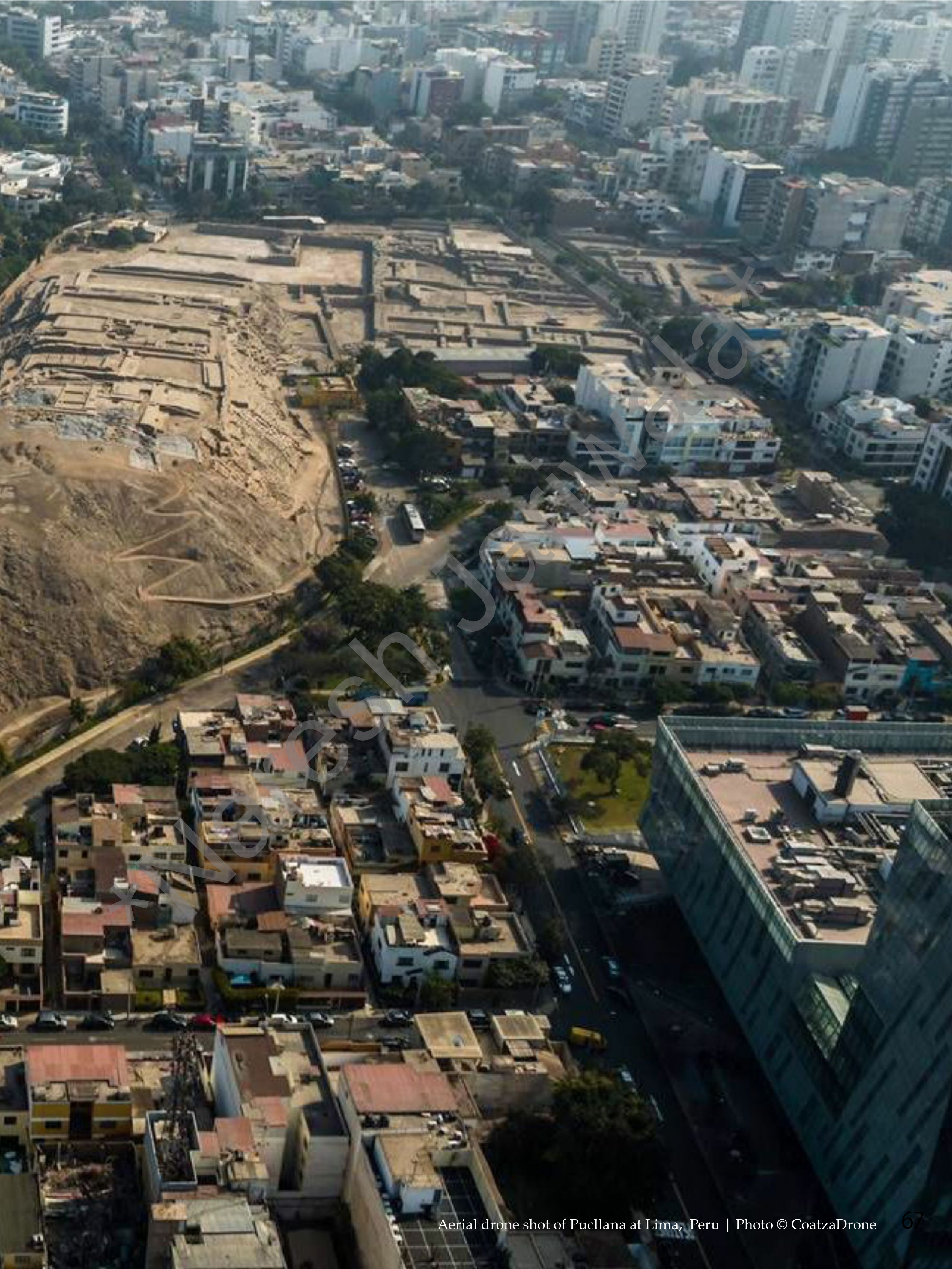




Huaca Pucllana is an adobe clay pyramid located in the Miraflores district of central Lima, Peru. It was built from seven staggered platforms and most likely served as an important ceremonial and administrative center for the Lima culture (100 – 650 AD). Its purpose might have been to house elite clergymen and enforce complete religious and political power over the natural water resources of the area.

The structure is surrounded by a plaza and a town square. A structured wall exists dividing the area into two separate sections. The first section contains benches and deep pits intended for fish and marine life offerings to the gods. The second section was most likely an administrative place due to the presence of small clay figurines and habitable structures made from adobe.

Huaca Pucllana, Peru



Aerial drone shot of Pucllana at Lima, Peru | Photo © CoatzaDrone

Naresh Jotiwala

A diorama of an ancient ritual offering with vessel at Huaca Pucllana

Specifically, with the Ministry of Culture, we have collaborated on planning, executing, and presenting digital products that help with the analysis of the archaeological sites that have been placed in our trust.

Will the results of your work, for example, 3D reconstructions, be presented to the public?

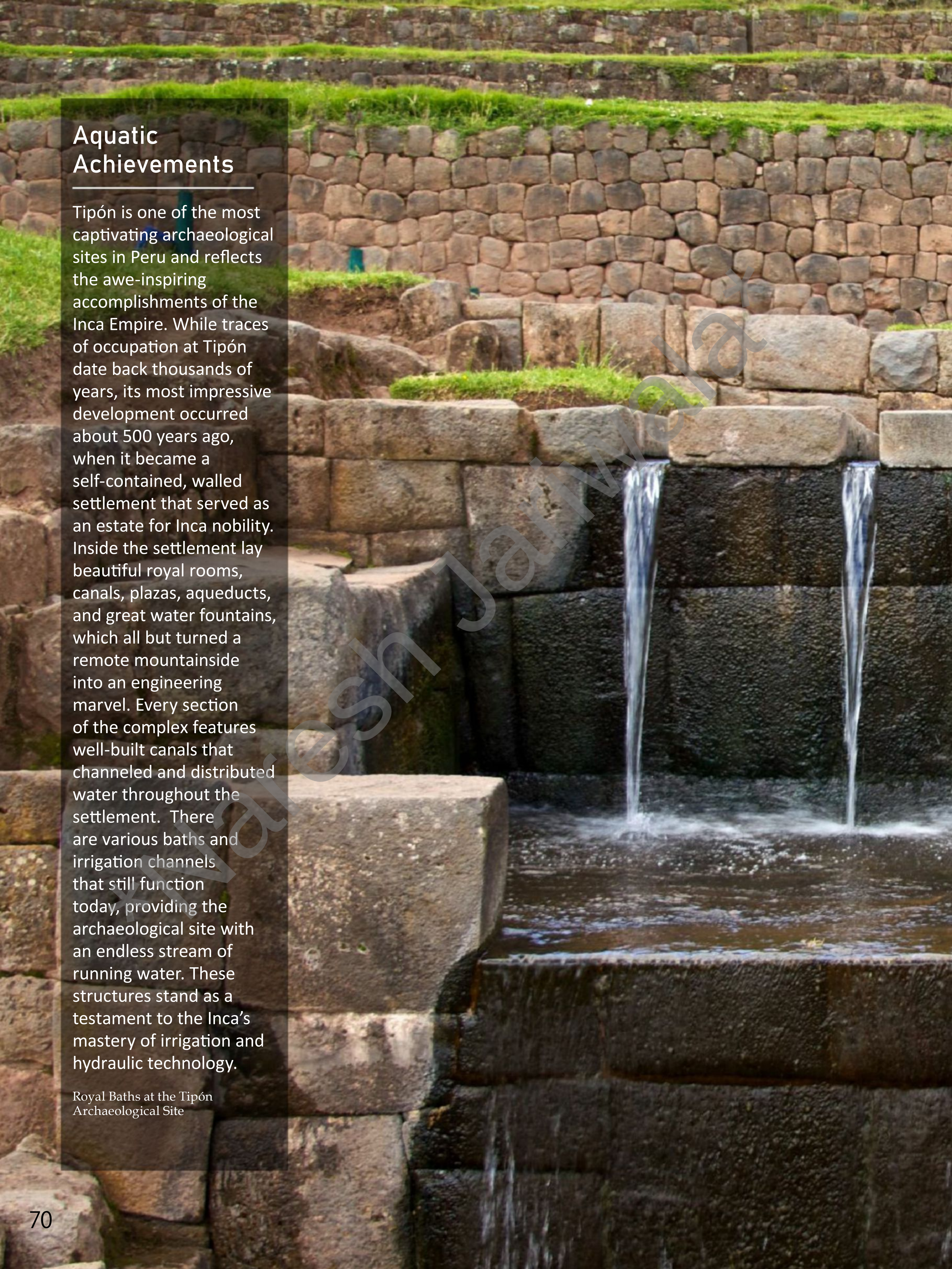
Some of the results have been presented by the Peruvian Ministry of Culture and at the Pix4D User Conference which was held last October in Denver, Colorado, USA. The conference presentation included a discussion on image processing at archaeological sites in Peru.

Can you tell us a bit about some of the other archaeological projects you've been working on and what you hope to achieve?

Another interesting archaeological project we have collaborated on was with the USMP, digitalizing the Puruchuco archaeological center. We have also worked with the Peruvian archaeologist Carls William Chuquihuaccha to make a digital version of the Ocucaje hill in Ica, Peru. This site contains a new discovery of geoglyphs or lines which are similar to the famous Nazca lines. In 2020, we will continue working on the project called *The Geoglyphs of Ica Archaeological Project*, an archaeological investigation of the surface material. ■

Álvaro Ruiz Molano wishes to thank the following collaborators who have worked with him on these projects: Lic. Jesús Fernández (CoatzaDrone Design), Ing. Alen Avellaneda (chief SIG y Lidar CoatzaDrone), Jimmy Cerna (Drone4Flight-Perú), Archaeologist Carls William Chuquihuaccha (MCP)

Naresh Jarimalla



Aquatic Achievements

Tipón is one of the most captivating archaeological sites in Peru and reflects the awe-inspiring accomplishments of the Inca Empire. While traces of occupation at Tipón date back thousands of years, its most impressive development occurred about 500 years ago, when it became a self-contained, walled settlement that served as an estate for Inca nobility. Inside the settlement lay beautiful royal rooms, canals, plazas, aqueducts, and great water fountains, which all but turned a remote mountainside into an engineering marvel. Every section of the complex features well-built canals that channeled and distributed water throughout the settlement. There are various baths and irrigation channels that still function today, providing the archaeological site with an endless stream of running water. These structures stand as a testament to the Inca's mastery of irrigation and hydraulic technology.

Royal Baths at the Tipón Archaeological Site

Naresh JaiMala

Hitesh Jariwala

A Golden Silk Orb-Weaver (Nephila inaurata)

THE SILK OF ONE MILLION SPIDERS

MAKES THE WORLD'S RAREST TEXTILE

BY WU MINGREN

In 2009, what is believed to be the world's largest and rarest piece of fabric made entirely from the silk of the golden silk orb-weaver was exhibited at the American Museum of Natural History in New York. It is said to be the only known piece of cloth made from natural spider silk in the world today. It is a breathtaking textile and the story of its creation is fascinating.

The production of the fabric was a project led jointly by Simon Peers, a British art historian who specializes in textiles, and Nicholas Godley, his American business partner. The project took five years to complete and cost approximately $390,000. The result of this endeavor was an 11.2-foot by 3.9-foot piece of textile.

THE INSPIRATION

The cloth produced by Peers and Godley is a gold-colored brocaded shawl/cape. The inspiration for this masterpiece was drawn by Peers from a French account dating to the 19th century. The account describes the attempt of a French Jesuit missionary by the name of Father Paul Camboué to extract and make fabrics from spider silk. While various attempts have been made in the past to turn spider silk into fabric, Father Camboué is regarded as the first person who succeeded in doing so. Nonetheless, spider web had already been harvested in ancient times for different purposes. The ancient Greeks, for instance, used spider web to stop wounds from bleeding.

As a missionary in Madagascar, Father Camboué utilized a species of spider found on the island to produce his spider web silk. Together with a business partner by the name of M. Nogué, a spider silk fabric industry was established on the island and one of their products, “a complete set of bed hangings” was even exhibited at the Paris Exposition of 1898. The work of the two Frenchmen has since been lost. Nevertheless, it received some attention at that time and provided inspiration for Peers and Godley’s undertaking about a century later.

EXTRACTING THE SPIDER SILK

One of the important things in Camboué and Nogué’s production of spider silk is a device invented by the latter to extract the silk. This small machine was hand-driven and was capable of extracting silk from up to 24 spiders simultaneously without hurting them. Peers managed to build a replica of this machine, and the ‘spider-silking’ process could begin.

> This small machine was hand-driven and capable of extracting silk from up to 24 spiders simultaneously without hurting them

Before this, however, the spiders had to be caught.

The spider used by Peers and Godley to produce their cloth is known as the red-legged golden orb-web spider (*Nephila inaurata*), which is a species native to Eastern and South-Eastern Africa, as well as several islands in the Western Indian Ocean, including Madagascar. Only the females of this species produce the silk, which they weave into webs. The webs glow in the sunlight and it has been suggested that this is meant either to attract prey or to serve as a camouflage.

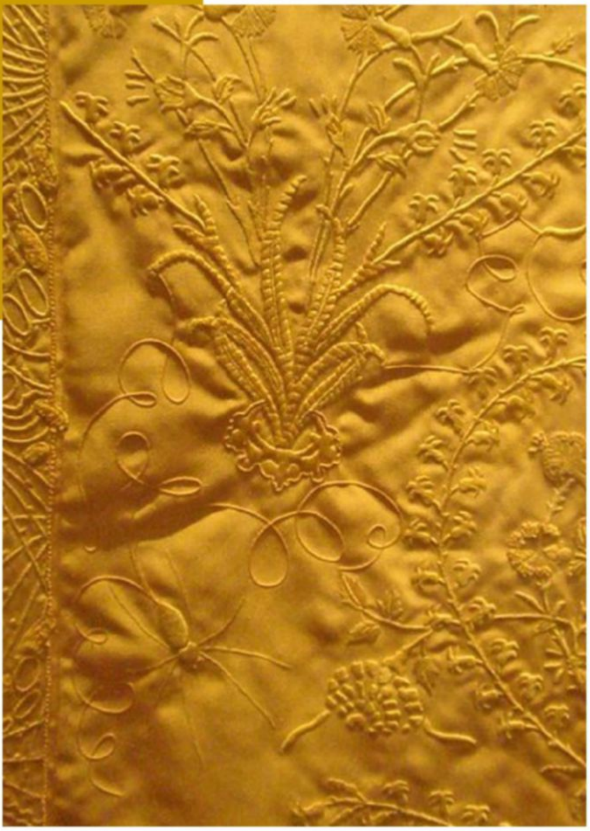
For Peers and Godley, as many as a million of these female red-legged golden orb-web spiders had to be captured in order to acquire enough silk for their cape. Fortunately, this is a common species of spider and it is abundant on the island. The spiders were returned to the wild once they ran out of silk. After a week, however, the spiders could generate silk once more. The spiders only produce their silk during the rainy season, so they were only caught during the months between October and June.

In 1709, François Xavier Bon de Saint Hilaire, the president of the Court of Accounts, Aides, and Finances in Montpellier, France, presented the King of France, Louis XIV, with a pair of silvery spider-silk gloves and stockings, woven from hundreds of spider egg sacs.

At the end of four years, a golden-colored cape was produced. It went on display first at the American Museum of Natural History in New York and then at the Victoria and Albert Museum in London. This piece of work proved that spider silk could indeed be used to make fabrics.

Nevertheless, it is not an easy product to mass-produce. When housed together, for example, these spiders tend to turn into cannibals. Still, spider silk has been found to be extremely strong, yet light and flexible, a property that intrigues many scientists. Therefore, researchers have been trying to obtain this silk by other means.

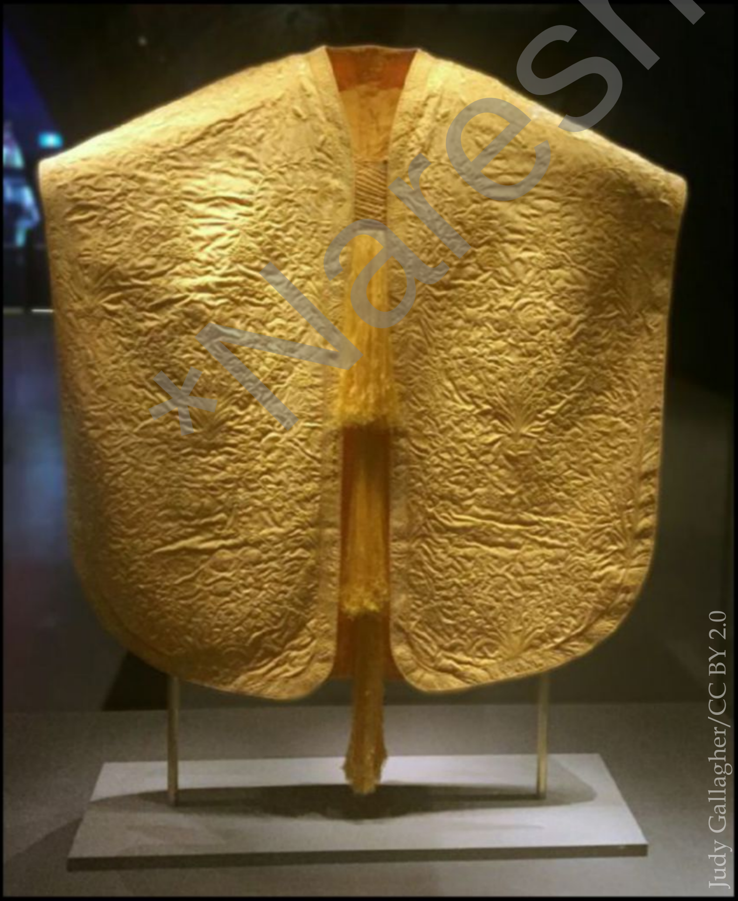
One, for instance, is to insert the spider genes into other organisms (such as bacteria, though some have tried it on cows and goats), and then to harvest the silk from them. Such attempts have only been moderately successful. It seems that for the time being, one will still need to catch a great number of spiders if one wishes to produce a piece of fabric from their silk. ■



Photos by Amanda Slater/CC BY 2.0

Left to right: Detailed workmanship on the cape featuring an orb spider; threads woven from the silk to create tassles; a spider's web

Below: The full cape made from over a million Madagascar Golden Orb spiders' silk



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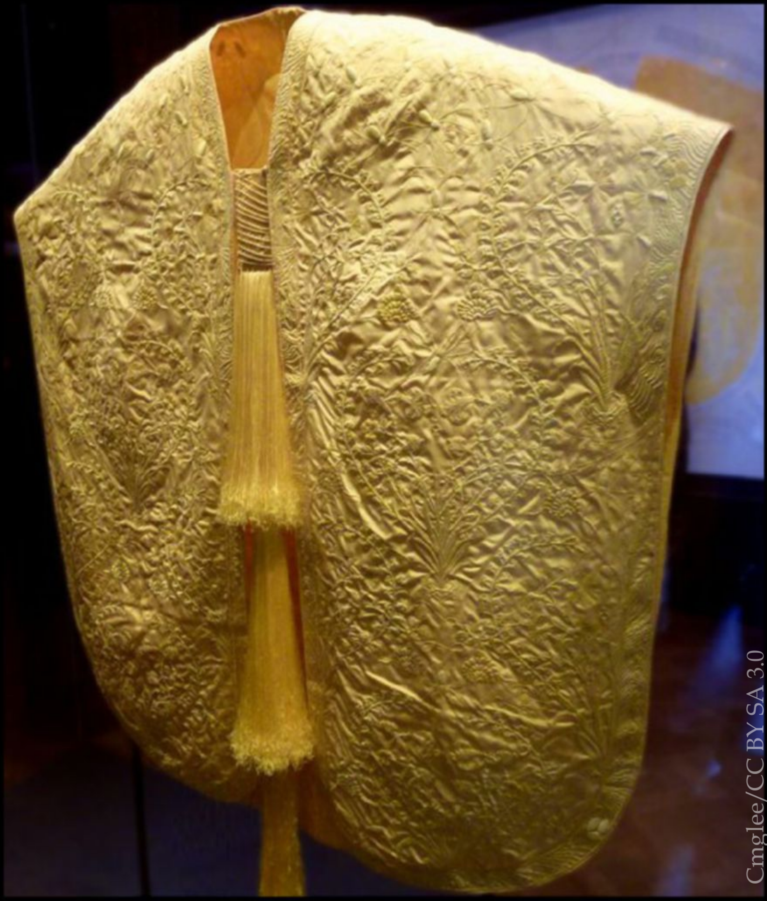

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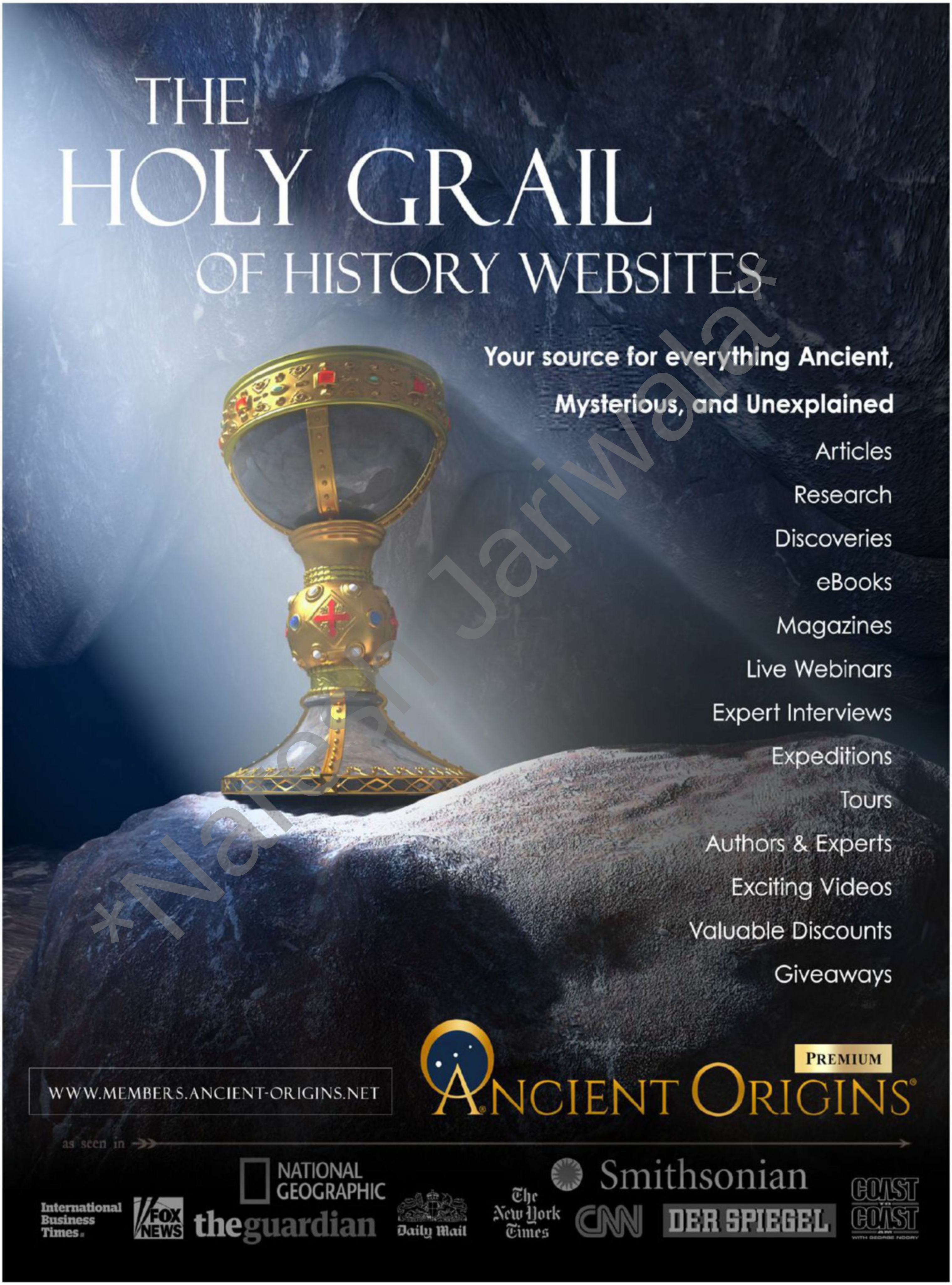

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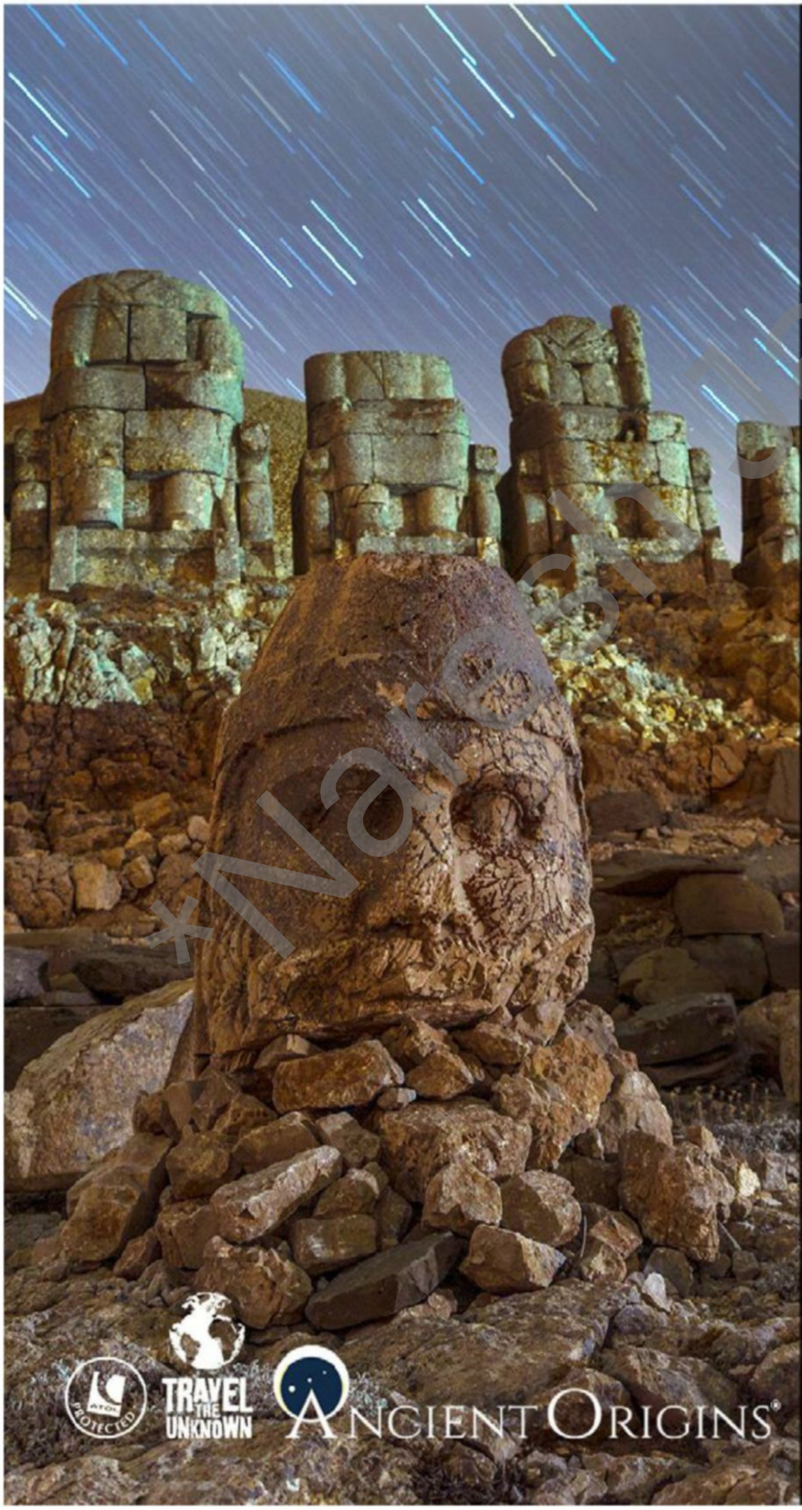

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Naresh Jariwala

Mysterious Mesopotamian Mersu

Mersu is one of the oldest known treats in the world. These date truffles come from Mari, Syria, and can be dated as far back as 1775–1761 BC.

But the mystery of mersu is that we actually don't know how it's made. In the 1930s, French archaeologists found thousands of tablets in Mari and mersu is mentioned on one of them. A cooking tablet in the Yale Babylonian Collection, (one of the best collections of Mesopotamian writings), have inspired the recipe below. As with many of the oldest recipes, there is no exact information available on how to

FOOD FIT FOR A KING!

prepare mersu. Archaeologists only have the ingredients thanks to a delivery letter that comes from the reign of King Zimri-Lim that says:

(Received) 120 liters of dates
And 10 liters of pistachios,
for making mersu.
Meal of the king,
The 14th of the month of Kiskissu,
of the year that followed
the seizing of Ašlakkâ by King
Zimri-Lim.

It is possible that other ingredients were added at times to vary the flavor and texture of mersu, such as butter or possibly semolina, but dates and pistachios are the basic mersu ingredients food historians agree upon. If it was made for a god or goddess offering, it is also possible that wine, cheese, apples, figs, or raisins, as well as other nuts, may have been included to make a more exquisite mersu. Depending on additional ingredients, mersu may have ranged from a candy to a pastry. It could have even been savory if onions or garlic were included, as some people have suggested.

When the Yale recipes were first translated by French historian Jean Bottéro and published in 1995 in *Textes Culinaires Mésopotamiens* it was believed that mersu was a cake both for the presence of dates and nuts, and the similarity between its name and the word *marâsu*, which means "to mix." However, there is nothing directly in the tablets or other ancient sources to suggest that mersu was a cake. A comparison between the staple ingredients and how the same are used in modern Levantine and Asian cuisines suggests that mersu could have just as easily been a date candy or truffle. If flour is added, mersu looks somewhat similar to the modern Iranian dessert called *ranginak* - dates stuffed with pistachios and enclosed in a thin crust of dough. This addition also places mersu in the same realm as the modern Lebanese *ma'moul*, which has a pounded-date center covered in a layer of semolina that is then covered in a layer of chopped pistachios.

Natural, unaltered, and unenhanced, the flavors in this basic mersu recipe are simple, but they're also rich enough that an ancient king (or even deity) would have been delighted to receive date and pistachio mersu as an offering. Ancient Sumerians developed professional cooking to please their gods and served them lavish, multiple-course meals every day.

It’s easy to imagine how ancient chefs could have crafted the delicious mixture into beautiful forms that would have pleased the recipient

With the prominence of the date as a Sumerian sweetener, it wouldn’t be surprising to think that mersu may have been in one of those courses.

The only information currently available on how to prepare mersu is that special Mari chefs were in charge of creating it by mixing the ingredients in large pots. Although most mersu recipes today create simple balls, it apparently was made into different shapes and sizes. When you work with the mersu dough, it’s easy to imagine how ancient chefs could have crafted the delicious mixture into beautiful forms that would have pleased the recipient.

Making mersu isn’t complicated either. Either chop, pound, and roll the ingredients to give yourself a little arm exercise for a half an hour or, if you’re comfortable with using a modern convenience, whizz it all up in a food processor.

One option to finish this recipe is to roll the mersu in shredded coconut, which adds a nice contrasting flavor. Coconut might have been known by the neo-Assyrian period but was probably not used at the time the original recipe was recorded. Some people also enjoy rolling the mersu in powdered chocolate, or stuffing them with walnuts, but again, while it may be tasty, these additions wouldn’t be authentic. Adding these ingredients might make the mersu closer to the modern Iraqi specialty which may have descended from it, *madgooga*. ■

MERSU

INGREDIENTS (TO MAKE ABOUT A DOZEN)

1 Cup of dates, pitted
1 Cup of raw pistachio nuts, unsalted and shelled

METHOD

Blend dates into a paste by pulsing them in a food processor. Or, if you prefer the authentic, Mesopotamian preparation technique, mashing or finely chopping and squishing the dates will produce the same results – but it takes a lot longer and will probably leave you with sore arms unless you are used to making bread.

Mince half of the pistachios and grind the other half.

Add the minced pistachios and pulse or mix them into the dates until you have a relatively smooth mixture.

Form the mersu mix into small balls by rolling about a tablespoon of the mixture in your hands. You may want to wet your hands to avoid some stickiness.

Finally, roll the balls in the ground pistachios in a bowl or on waxed paper, patting each one gently to ensure the nuts stick.

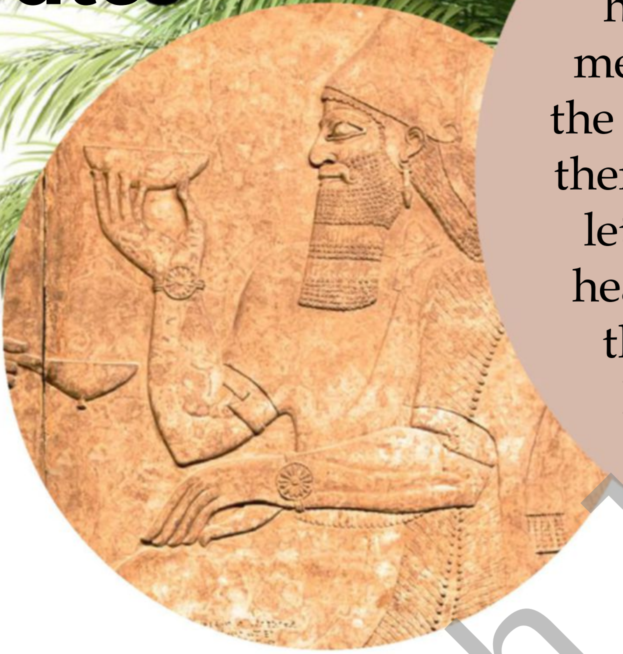
Enjoy as a nice snack or energy-boosting treat, knowing that thousands of years ago a Mesopotamian king also enjoyed these tasty and natural delights!

Stores in an airtight container for several weeks, but you'll likely have eaten them before then! ■

Photos © Alicia McDermott

Naresh Jaiswal

A Short and *Sweet* History of Dates



> "For
> me, let them
> bring in the man of my
> heart. Let them bring in to
> me my Ama-ushumgal-anna,
> the Power of the Date-Palm. Let
> them put his hand in my hand,
> let them put his heart by my
> heart. As hand is put to head,
> the sleep is so pleasant. As
> heart is pressed to heart,
> the pleasure is so
> sweet."

kunĝar (Sumerian religious song) to Inanna

Naresh Jaiwala

Phoenix dactylifera, aka dates or palm dates, are considered the oldest cultivated fruit in the world. Fossil evidence suggests dates have been around for at least 50 million years. They originated in the Middle East and it's believed there are more than 3,000 varieties of dates in existence today. Known for their chewy texture and candy-like sweetness, dates have sometimes been referred to as the "bread of the dessert" or "cake of the poor."

The scientific name comes from the ancient Greeks and their link between the fruit and its abundance in Phoenicia, which they thought was its homeland. *Phoenix* is a reference to that belief and *dactylifera* translates to "finger bearing," due to the oblong shaped and the clusters dates grow in. Pliny the Elder also wrote that the phoenix bird built its nest on top of date palms and the tree and bird would die and be reborn together.

The date palm has also been referred to as the original Tree of Life because ancient holy books, folklore, art, and architecture have all cast it in that light. That belief also likely relates to the large quantity of fruit that can be produced by a single tree, as many as a thousand dates, in the right conditions. That's also why dates and the date palm are associated with hospitality, long life, fertility, and prosperity.

The Sumerians linked the tree with their fertility god Dumuzid, whose title Ama-ushumgal-anna means "The Power of the Date-Palm." He was married to the goddess Inanna and their union was connected to date harvesting and storage by the ancient Sumerians. Inanna stored the dates and Dumuzid provided the fruit. Some scholars believe the sacred union of these deities was celebrated as a physical act between the high priestess of Inanna and the local king and through songs such as the one above.■

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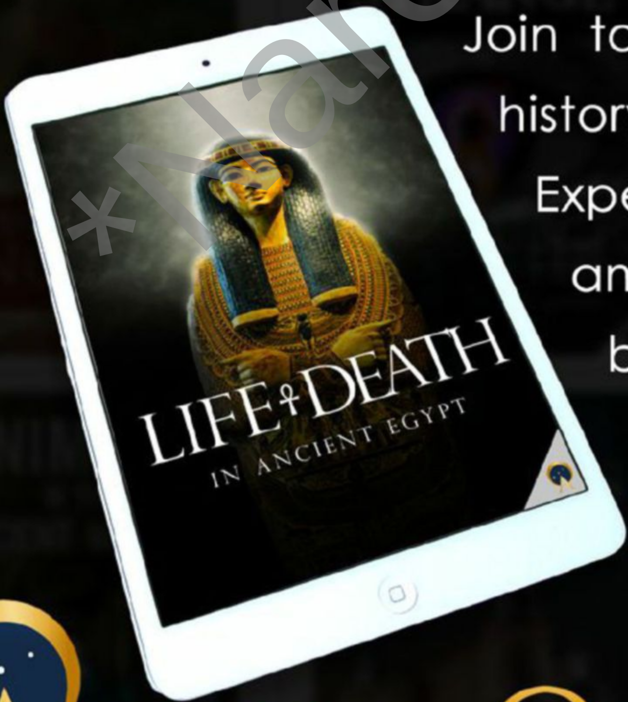
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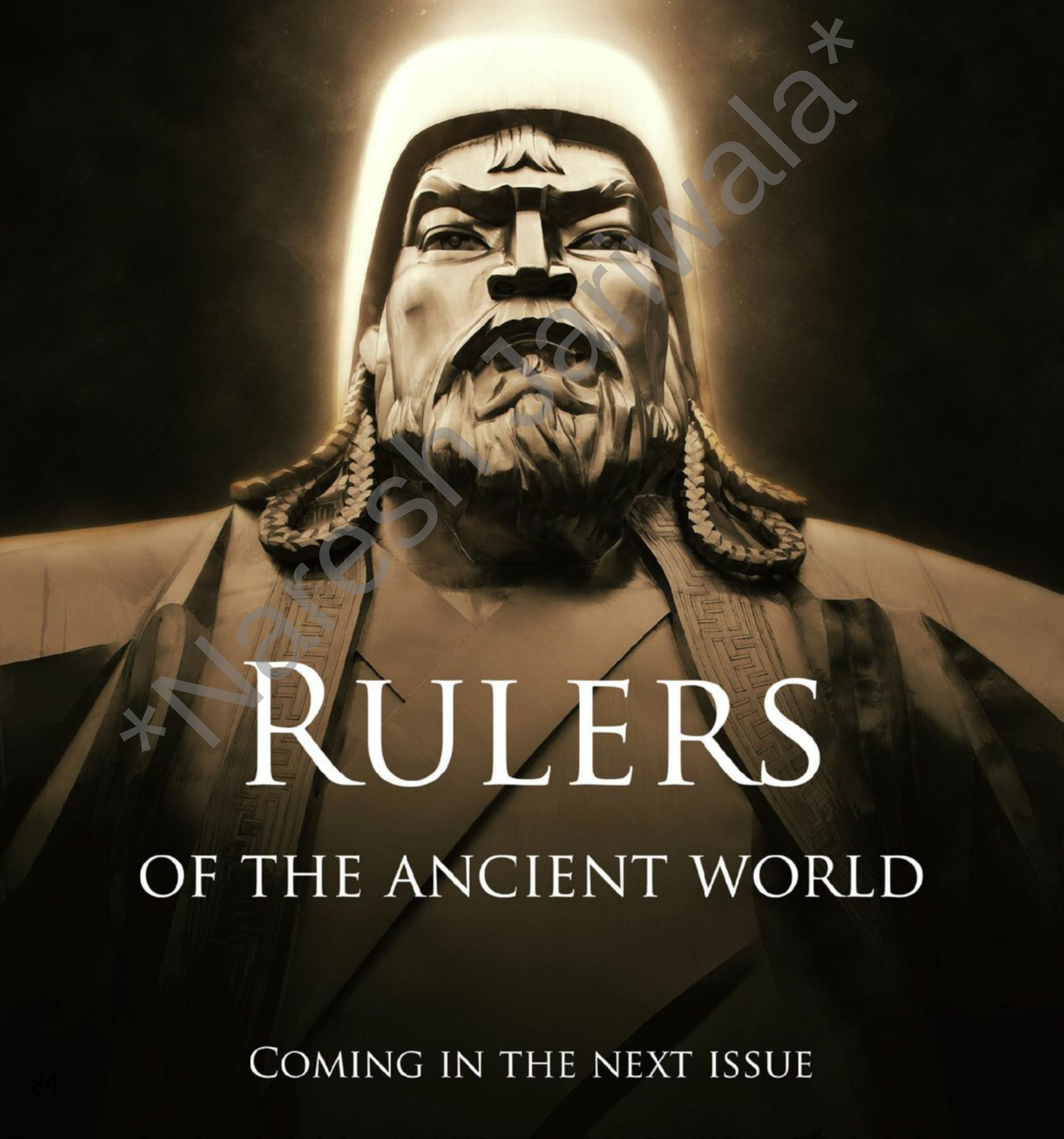

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